M.Sc. (CHEMISTRY)
(Effective from the Session 2004-2005)

M.Sc. Previous

Teaching Scheme				Contact Hours per week		Exam. Duration (hr.)		Distribution of Marks				
S. No.	Paper No.	Paper's Title	Credit	L	P	T	P	CWS	PRS	TE	PE	Total
I SEMESTER												
1.	MCH- 411	Analytical Chemistry-I	3	3	—	3	—	30	—	70	—	100
2.	MCH- 412	Inorganic Chemistry-I	3	3	—	3	—	30	—	70	—	100
3.	MCH- 413	Organic Chemistry-I	3	3	—	3	—	30	—	70	—	100
4.	MCH- 414	Physical Chemistry-I	3	3	—	3	—	30	—	70	—	100
5.	MCH- 415	Chemical Binding	3	3	—	3	—	30	—	70	—	100
6.	MCH- 416(I)	Laboratory Work-I (Inorganic Chemistry)	2	—	4	—	6	—	30	—	70	100
	MCH- 416(O)	Laboratory Work-I (Organic Chemistry)	2	—	4	—	6	—	30	—	70	100
	MCH- 416(P)	Laboratory Work-I (Physical Chemistry)	2	—	4	—	6	—	30	—	70	100
		Sub Total	**21**									**800**
II SEMESTER												
1.	MCH- 421	Analytical Chemistry-II	3	3	—	3	—	30	—	70	—	100
2.	MCH- 422	Inorganic Chemistry-II	3	3	—	3	—	30	—	70	—	100
3.	MCH- 423	Organic Chemistry-II	3	3	—	3	—	30	—	70	—	100
4.	MCH- 424	Physical Chemistry-II	3	3	—	3	—	30	—	70	—	100
5.	MCH- 425	Molecular Spectroscopy	3	3	—	3	—	30	—	70	—	100
6.	MCH- 426	Biological Chemistry	3	3	—	3	—	30	—	70	—	100
7.	MCH- 427(I)	Laboratory Work-II (Inorganic Chemistry)	2	—	4	—	6	—	30	—	70	100
	MCH- 427(O)	Laboratory Work-II (Organic Chemistry)	2	—	4	—	6	—	30	—	70	100
	MCH- 427(P)	Laboratory Work-II (Physical Chemistry)	2	—	4	—	6	—	30	—	70	100
		Sub Total	**24**									**900**

M.Sc. Final

Teaching Scheme				Contact Hours per week		Exam. Duration (hr.)		Distribution of Marks				
S. No.	Paper No.	Paper's Title	Credit	L	P	T	P	CWS	PRS	TE	PE	Total
III SEMESTER												
1.	MCH- 531	Solid State Chemistry	3	3	—	3	—	30	—	70	—	100
2.	MCH- 532	Major Elective-I	3	3	—	3	—	30	—	70	—	100
3.	MCH- 533	Major Elective-II	3	3	—	3	—	30	—	70	—	100
4.	MCH- 534	Major Elective-III	3	3	—	3	—	30	—	70	—	100
5.	MCH- 535	Laboratory Work-III (Specialization wise)	6	—	12	—	7	—	30	—	70	100
6.	MCH- 63X	Minor Elective-I	2	2	—	2	—	15	—	35	—	50
7.	MCH-63X	Minor Elective-II	2	2	—	2	—	15	—	35	—	50
		Sub Total	**22**									**600**
IV SEMESTER												
1.	MCH- 541	Environmental Chemistry	3	3	—	3	—	30	—	70	—	100
2.	MCH- 542	Computer Applications in Chemistry	3	1.5	3	2	4	15	15	35	35	100
3.	MCH- 543	Major Elective-IV	3	3	—	3	—	30	—	70	—	100
4.	MCH- 544	Major Elective-V	3	3	—	3	—	30	—	70	—	100
5.	MCH- 545	Laboratory Work-IV (Specialization wise)	6	—	12	—	7	—	30	—	70	100
6.	MCH- 64X	Minor Elective-III	2.5	2.5	—	3	—	15	—	35	—	50
7.	MCH- 64X	Minor Elective-IV	2.5	2.5	—	3	—	15	—	35	—	50
		Sub Total	**23**									**600**
		Total	**90**									**2900**

X may be any number from 1 to 7.
L – Lecture **P** – Practical **T** – Theory **CWS** – Class Work Sessional **PRS** – Practical Sessional
TE – Theory Examination **PE** – Practical Examination

Total Credits : 90 (Core = **54**, Major Electives (15) + Special Practical (12) = **27,** Minor Elective = **9**)

Major Electives I-III

(one of the following specializations to be selected)

1.	**Analytical Chemistry Specialization**	
	MCH-532 (A)	Principles of Analytical Chemistry
	MCH-533 (A)	Spectrochemical Analysis
	MCH-534 (A)	Microanalytical Techniques
2.	**Inorganic Chemistry Specialization**	
	MCH-532 (I)	Organometallic Chemistry of Transition Metals
	MCH-533 (I)	Bio-inorganic Chemistry
	MCH-534 (I)	Structural Methods in Inorganic Chemistry
3.	**Organic Chemistry Specialization**	
	MCH-532 (O)	Application of Spectroscopy to Structural Analysis
	MCH-533 (O)	Reaction Mechanisms and Stereochemistry
	MCH-534 (O)	Natural Products
4.	**Physical Chemistry Specialization**	
	MCH-532 (P)	Electrochemistry
	MCH-533 (P)	Chemical Kinetics
	MCH-534 (P)	Quantum Chemistry

Mode for opting Specialization (Major Electives) : The number of seats in each specialization would be up to a maximum of 30 % of the total eligible candidates.

Major Electives IV & V

(one of the following groups as per specialization to be selected)

1.	**Analytical Chemistry Specialization**	
	MCH-543 (A)	Separation Techniques
	MCH-544 (A)	Electroanalytical Methods
2.	**Inorganic Chemistry Specialization**	
	MCH-543 (I)	Inorganic Rings, Chains, and Clusters
	MCH-544 (I)	Special Topics in Inorganic Chemistry
3.	**Organic Chemistry Specialization**	
	MCH-543 (O)	Reagents and Organic Synthesis
	MCH-544 (O)	Heterocycles and Vitamins
4.	**Physical Chemistry Specialization**	
	MCH-543 (P)	Statistical Mechanics
	MCH-544 (P)	Physical Methods in Chemistry

Minor Electives

(Any 2 to be taken in III Semester from Group A and any 2 in IV Semester from Group B)

Group-A	Group-B
MCH-631 Materials Chemistry	MCH-641 Modern Nuclear Magnetic Resonance Techniques
MCH-632 Polymer Chemistry	MCH-642 Inorganic Photochemistry
MCH-633 Molecular Reaction Dynamics	MCH-643 Bio-organic Chemistry
MCH-634 Radio and Radiation Chemistry	MCH-644 Chemical Applications of Group Theory
MCH-635 Medicinal Chemistry	MCH-645 Industrial Chemical Analysis and Quality Control
MCH-636 Organic Photochemistry	MCH-646 Nuclear Chemistry
MCH-637 Forensic Analysis	MCH-647 Photochemistry

Note : Depending upon the facilities, the Minor Electives floated in each of III & IV Semester will be announced separately. To run a particular Minor Elective, at least 5 students should opt for it.

I SEMESTER

MCH-411 : ANALYTICAL CHEMISTRY-I (BASIC CONCEPTS)

40 Lectures

1. ***Introduction:*** Scope & objectives, Analytical chemistry and chemical analysis, Classification of analytical methods, Method selection, Sample processing, Steps in a quantitative analysis, Quantitative range (bispartite classification), Data organisation, Analytical validations, Limit of detection and limit of quantitation, The tools of analytical chemistry and good lab practices.

2. ***Errors in Chemical Analysis and Statistical Evaluation of Data:*** Systematic and random errors, Accuracy and precision, Ways of expressing accuracy and precision, Normal error curve and its equation, Propagation of error, Useful statistical test: test of significance, the F test, the student 't' test, the chi-test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, significant figures, regression analysis (least-square method for linear plots), statistics of sampling and detection limit evaluation.

3. ***Concept of Equilibrium:*** Solvents and solutions, general treatment of equilibria in aqueous medium involving monoprotic weak acid and weak base, and salts of weak acids and weak bases. Activity and concentration, Effect of electrolytes on chemical equilibria, Calculation of pH, Constructing titration curves from charge balance and mass balance equations, Acid-base titrations and theory of pH indicators, Complexation equilibria and complexometric titrations, Redox equilibria and redox titration, Theory of redox indicators, Precipitation reaction and precipitation titrations and theory of adsorption indicators.

4. ***Spectrophotometric Determination of Stoichiometry of Complexes:*** Job's method of continuous variation, mole ratio and slope ratio analysis, Advantages and limitations, Typical examples.

5. ***Automation in the Laboratory:*** Principles of automation, Process control through automated instruments, Autoanalyzers (single channel and multi-channel), Basic sequences of multi-fold operational analyzers in segmented and non-segmented flows.

Books Recommended

1. R. L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, *Modern Methods of Chemical Analysis*, 2nd Edition (1976), John Wiley, New York.
2. G. D. Christian, *Analytical Chemistry*, 5th Edition (1994), John Wiley & Sons, New York.
3. D. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, *Analytical Chemistry - An Introduction*, 7th Edition (2000), Saunders College Publishing, Philadelphia, London.
4. J. H. Kennedy, *Analytical Chemistry: Principles*, 2nd Edition (1990), Saunders Holt, London.

MCH-412 : INORGANIC CHEMISTRY-I

40 Lectures

1. **Metal-Ligand Bonding in Transition Metal Complexes :** Crystal field splitting diagrams in complexes of low symmetry; Spectrochemical and Nephelauxetic series; thermodynamic and structural effects; site selection in spinels, Jahn-Teller distortions; experimental evidence for metal-ligand orbital overlap; ligand field theory, molecular orbital theory of octahedral complexes.
2. **Electronic Spectra of Transition Metal Complexes :** Spectroscopic ground states; Orgel energy level and Tanabe-Sugano diagrams for transition metal complexes; Charge transfer spectra; electronic spectra of octahedral and tetrahedral Co(II) and Ni(II) complexes and calculation of ligand-field parameters.
3. **VSEPR Theory :** Valence Shell Electron Pair Repulsion Theory-stereochemical rules and explanation of the shapes of molecules and ions of non-transition elements with 2-7 valence shell electron pairs.
4. **HSAB Theory :** Classification of acids and bases as hard and soft; HSAB principle, theoretical basis of hardness and softness; Lewis-acid base reactivity approximation; donor and acceptor numbers, E and C equation; applications of HSAB concept.

Books Recommended

1. F.A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry*, 6th Edn. (1999), John Wiley & Sons, New York.
2. James E. Huheey, *Inorganic Chemistry*, 4th Edn. (1993), Addison-Wesley Pub. Co., New York.
3. R. S. Drago, *Physical Methods in Inorganic Chemistry*, International Edn. (1971), Affiliated East-West Press, New Delhi.

MCH-413 : ORGANIC CHEMISTRY-I

40 Lectures

1. **Aromaticity:** Benzenoid and nonbenzenoid systems, antiaromaticity.
2. **Effects of Structure on Reactivity:** Linear free energy relationships (LFER), the Hammett equation - substituent and reaction constants; the Taft treatment of polar and steric effects in aliphatic compounds.
3. **Nucleophilic Substitution at Saturated Carbon:** Mechanism and Stereochemistry of S_N1, S_N2, SNi and S_N2' reactions. The reactivity effects of substrate structure, solvent effects, competition between S_N1 and S_N2 mechanisms.
4. **Electrophilic Aromatic Substitution:** The Arenium ion mechanism, orientation and reactivity in monosubstituted benzene rings, ortho/para ratio. *Ipso* substitution.
5. **Nucleophilic Aromatic substitution:** The Aromatic S_N1, S_N2 and benzyne mechanisms. Reactivity – effect of substrate structure, leaving group, and attacking nucleophile.

Books recommended:

1. M.B. Smith & Jerry March, *March's Advanced Organic Chemistry*, 5th Edition (2001), John Wiley & Sons, New York.
2. Peter Sykes, *A Guide book to Mechanism in Organic Chemistry*, 6th Edition (1997), Orient Longman Ltd., New Delhi.
3. S.M. Mukherjee and S.P. Singh, *Reaction Mechanism in Organic Chemistry*, Ist Edition (1990), Macmillan India Ltd., New Delhi.
4. T.H. Lowry and K.S. Richardson, *Mechanism and Theory in Organic Chemistry*, 3rd Edition (1998), Addison – Wesley Longman Inc. (IS Edition)
5. R.T. Morrison and R.N. Boyd, *Organic Chemistry*, 6th Edition (2003), Prentice- Hall of India, New Delhi.
6. P.S. Kalsi, *Organic Reactions and Their Mechanisms*, Ist Edition (1996), New Age International Pub., New Delhi.

MCH-414 : PHYSICAL CHEMISTRY-I

40 Lectures

1. **Electrochemistry :** Metal/Electrolyte interface **:** OHP and IHP, potential profile across double layer region, potential difference across electrified interface; Structure of the double layer **:** Helmholtz-Perrin, Gouy-Chapman, and Stern models. Butler-Volmer equation under near equilibrium and non-equilibrium conditions, exchange current density, Tafel plot. Polarizable and non-polarizable interfaces.

2. **Chemical Kinetics :** Composite Reactions - types of composite mechanisms, rate equations for composite mechanisms, simultaneous and consecutive reactions, steady state treatment, rate-determining steps, microscopic reversibility and detailed balance, dynamic chain (H_2-Br_2 reaction, decomposition of ethane and acetaldehyde) and oscillatory reactions (Belousov-Zhabotinskii reaction), branching chain : H_2-O_2 reaction.

3. **Surface Chemistry and Catalysis :** Interphase region, curved surfaces. Thermodynamics of surfaces **:** Gibbs adsorption isotherm, heat and entropy of adsorption. Surface film on liquids; Electro-kinetic phenomena.

   Catalytic activity at surfaces (volcano curve), Surface area determination (BET equation), transition state theory of surface reactions: rates of chemisorption and desorption, unimolecular and bimolecular surface reactions, comparison of homogeneous and heterogeneous reaction rates, surface heterogeneity, lateral interaction.

4. **Thermodynamics :** Partial molar properties and their significance. Fugacity : its concept and determination. Properties of ideal solutions; non-ideal systems-deviations (negative and positive) from ideal behaviour, excess functions for non-ideal solutions, calculations of partial molar quantities, determination of partial molar volume and partial molar enthalpy.

Books Recommended

1. J.O'M. Bockris and A. K. N. Reddy, *Modern Electrochemistry*, Vol. 2 A & B, Second Edition (1998), Plenum Press, New York.
2. K. J. Laidler, *Chemical Kinetics*, Third Edition (1987), Harper & Row, New York.
3. P. W. Atkins, *Physical Chemistry*, Seventh Edition (2002), Oxford University Press, New York.
4. I.N. Levine, *Physical Chemistry*, 5th Edition (2002),Tata McGraw Hill Pub. Co. Ltd., New Delhi.
5. J. Raja Ram and J.C. Kuriacose, *Kinetics and Mechanism of Chemical Transformations* (1993), MacMillan Indian Ltd., New Delhi.

MCH-415 : CHEMICAL BINDING

40 Lectures

1. **Fundamental Background :** Postulates and theorems of quantum mechanics. Angular momentum. Rigid Rotor.
2. **The Schrödinger Equation and its Exact Solutions :** The particle-in-a-box. Hydrogen atom. The variation Theorem - Ritz variation principle.
3. **Atomic Structure :** Many electron wave functions. Pauli Exclusion principle. Helium atom. Atomic term symbols. The self-consistent field method. Slater-type orbitals.
4. **Symmetry Point Groups :** Determination of point group of a molecule. Representations. The great orthogonality theorem. Character table. Construction of character tables for C_{2v} and C_{3v} groups. Symmetry adapted atomic basis sets. Construction of molecular orbitals. The direct product representation.
5. **Molecular Structure :** Born-Oppenheimer approximation. Molecular orbital treatment for H_2^+. MO treatment of homo- and hetero nuclear diatomic molecules. Hückel MO treatment of simple and conjugated polyenes. Alternant hydrocarbons.

Books Recommended:

1. I.N. Levine, *Quantum Chemistry*, 5th edition (2000), Pearson Educ. Inc., New Delhi.

2. D.A. Mc Quarrie and J.D. Simon, *Physical Chemistry: A Molecular Approach*, (1998) Viva Books, New Delhi.
3. J.N. Murrell, S.F.A. Kettle and J. M. Tedder, *Valence Theory*,2nd edition (1965), John Viley, New York.
4. A.K. Chandra, *Introductory Quantum Chemistry*, 4th edition (1994), Tata McGraw Hill, New Delhi.
5. M. Karplus and R. N. Porter, *Atoms and Molecules* (1970), Benjamin, London.
6. L. Pauling and E. B. Wilson, *Introduction to Quantum Mechanics with Applications to Chemistry* (1935), McGraw Hill, New York.

II SEMESTER

MCH-421 : ANALYTICAL CHEMISTRY-II

(Techniques in Analytical Chemistry)

40 Lectures

1. **Polarography :** Origin of polargraphy, Current-voltage relationship, Theory of polarographic waves (DC and sampled DC (tast) polarograms), Instrumentation, Ilkovič equation, Qualitative and quantitative applications.
2. **Atomic Spectroscopy :** Theory, Instrumentation and applications of X-rays (emission, absorption, diffraction and fluorescence methods), Atomic absorption Spectroscopy, Atomic fluorescence spectrometry, Atomic emission spectrometry.
3. **Molecular Spectroscopy :** UV-visible molecular absorption spectrometry (instrumentation and applications), Molecular luminescence spectroscopy (fluorescence, phosphorescence, chemiluminascence), Mass spectroscopy.
4. **Separation Methods :** Principle of chromatography, Classifications of chromatography, Techniques of planar and column chromatography, Gas chromatography, High-performance liquid chromatography.
5. **Thermal Analysis :** Theory, methodology and applications of thermogravimetric analysis (TGA), Differential Thermal Analysis (DTA), and Differential scanning calorimetry (DSC). Principles, techniques and applications of thermometric titration methods.

Books Recommended

1. D.A. Skoog, *Principles of Instrumental Analysis*, 5th Edition (1998), Saunders College Publishing, Philadelphia, London.
2. G.W. Ewing, *Instrumental Methods of Chemical Analysis*, 5th Edition (1978), McGraw Hill Books Co., New York.
3. R.L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, *Modern Methods of Chemical Analysis*, 2nd Edition (1976), John Wiley, New York.
4. J.H. Kennedy, *Analytical Chemistry: Principles*, 2nd Edition (1990), Saunders Holt, London.

MCH-422 : INORGANIC CHEMISTRY-II

40 Lectures

1. **Kinetics and Mechanism of Substitution Reactions :** Nature of substitution reactions; prediction of reactivity of octahedral, tetrahedral and square-planar complexes in terms of VBT and CFT; rates of reactions; acid hydrolysis, base hydrolysis and anation reactions.
2. **Electron Transfer Reactions :** Mechanism and rate laws; various types of electron transfer reactions, Marcus-Husch theory, correlation between thermal and optical electron transfer reactions; identification of intervalence transfer bands in solution.
3. **Metal Carbonyls :** Preparation and structure; vibrational spectra of metal carbonyls, reactions of metal carbonyls.
4. **Optical Rotatory Dispersion and Circular Dichroism :** Linearly and circularly polarized lights; optical rotatory power and circular birefringence, elipticity and circular dichroism; ORD and Cotton effect, Faraday and Kerr effects; Assignment of electronic transitions; applications of ORD and CD for the determination of (i) absolute configuration of complexes and (ii) isomerism due to non-planarity of chelate rings.

Books Recommended

1. F. Basalo and R. G. Pearson, *Mechanism of Inorganic Reactions*, 2nd Edn (1967), Wiley Eastern Ltd., New Delhi.
2. D. F. Shriver and P. W. Atkins, *Inorganic Chemistry*, 3rd Edn. (1999), ELBS, London.
3. F. A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry*, 6th Edn. (1999), John Wiley & Sons, New York.
4. D.N. Sathyanarayana, *Electronic Absorption Spectroscopy and Related Techniques* (2001), Universities Press (India) Ltd., Hyderabad.

MCH-423 : ORGANIC CHEMISTRY-II

40 Lectures

1. **Addition to Carbon–Carbon Multiple Bonds :** Electrophilic, free-radical and nucleophilic mechanisms-Mechanistic and Stereochemical aspects. Orientation and reactivity. Hydroboration and Michael reaction.
2. **Esterification and Hydrolysis of Esters :** Evidence for tetrahedral intermediate in BAc^2 and AAc^2 mechanisms, steric and electronic effects. The AAc^1 and other pathways involving alkyl-to-oxygen bond cleavage.

3. **Elimination reactions :** The E1, E2 and E1cB mechanisms, Orientation of the double bond. Hofmann versus Saytzeff elimination, Pyrolytic *syn*-elimination, Competition between substitution and elimination reactions.

4. **Introduction to Conservation of Orbital Symmetry in Pericylic Reactions :** Woodward-Hoffmann rules; cycloaddition [2+2] and [4+2], and electrocylic reactions. Prototropic and Sigmatropic rearrangements, Ene reactions and Cheletropic reactions; 1,3-Dipolar cycloaddition.

Books recommended

1. M.B. Smith & Jerry March, *March's Advanced Organic Chemistry*, 5th Edition (2001), John Wiley & Sons, New York.
2. Peter Sykes, *A Guide Book to Mechanism in Organic Chemistry*, 6th Edition (1997), Orient Longman Ltd., New Delhi.
3. S.M. Mukherjee and S.P. Singh, *Reaction Mechanism in Organic Chemistry*, Ist Edition (1990), Macmillan India Ltd., New Delhi.
4. T.H. Lowry and K.S. Richardson, *Mechanism and Theory in Organic Chemistry*, 3rd Edition (1998), Addison – Wesley Longman Inc. (IS Edition).
5. R.T. Morrison and R.N.Boyd, *Organic Chemistry*, 6th Edition (2003), Prentice- Hall of India, New Delhi.
6. P.S. Kalsi, *Organic Reactions and Their Mechanisms*, Ist Edition (1996), New Age International Pub., New Delhi.
7. S.M. Mukherjee and S.P. Singh, *Pericyclic Reactions*, MacMillan India, New Delhi.
8. I. Fleming, *Pericyclic Reactions* (1999), Oxford University Press, Oxford.
9. I. Fleming, *Frontier Orbitals and Organic Chemical Reactions* (1976), Wiley, New York.

MCH-424 : PHYSICAL CHEMISTRY-II

40 Lectures

1. **Electrochemistry :**

Corrosion : Scope and economics of corrosion, causes and types of corrosion, electrochemical theories of corrosion, kinetics of corrosion (corrosion current and corrosion potential). Corrosion measurements (weight loss, OCP measurement, and polarization methods), units of corrosion rate,

passivity and its breakdown,. Corrosion prevention (electrochemical, inhibitor, and coating methods).

Cyclic Voltammetry : Cell design, instrumentation, current-potential relation for linear sweep voltammetry (LSV), cyclic voltammetry, interpretation of voltammograms.

2. **Statistical Thermodynamics :** Concepts of distribution, thermodynamic probability and most probable distribution. Ensemble averaging, postulates of ensemble averaging. Canonical and microcanonical ensembles, Boltzmann distribution of particles.

   Partition function : translational, rotational, vibrational partition functions, thermodynamic properties of ideal gases in terms of partition function.

3. **Micelles and Macromolecules :** Surface active agents and their classification, micellization, hydrophobic interaction, critical micellar concentration (cmc), factors affecting cmc of surfactants, counter ion binding to micelles, thermodynamics of micellization-phase separation and mass action models, solubilization, micro emulsions, reverse micelles.

   Macromolecules : Polymers-definition, types of polymers, liquid crystal polymers. Molecular mass-number and mass average molecular mass, determination of molecular mass (osmometry, viscosity, diffusion, light scattering, and sedimentation methods).

4. **Nuclear Chemistry :** Nuclear stability and binding energy. Mass and binding energy systematics. Nuclear isomerism and internal conversion. Nuclear fission and nuclear fusion- fission cross-section, chain fission, fission product and fission yield, mass and charge distribution in fission. Nuclear fusion and stellar energy.

Books Recommended

1. J.O'M. Bockris and A. K. N. Reddy, *Modern Electrochemistry*, Vol. 2, Second Edition, (1998) Plenum Press, New York.
2. P. W. Atkins, *Physical Chemistry*, 7th Edition, (2002) Oxford University Press, New York.
3. I. N. Levine, *Physical Chemistry*, 5th Edition (2002), Tata McGraw Hill Pub. Co. Ltd., New Delhi.
4. Andrew Maczek, *Statistical Thermodynamics,* (1998) Oxford University Press Inc., New York.
5. Y. Moroi, *Micelles : Theoretical and Applied Aspects*, (1992) Plenum Press, New York.
6. F.W. Billmayer, Jr., *Text Book of Polymer Science,* 3rd Edition (1984), Wiley-Interscience, New York.
7. B. G. Harvey, *Introduction to Nuclear Physics and Chemistry,* (1969) Prentice Hall, Inc.
8. H.J. Arnikar, *Essentials of Nuclear Chemistry*, 4th Edition (1995), Wiely-Eastern Ltd., New Delhi.

MCH-425 : MOLECULAR SPECTROSCOPY

40 Lectures

1. **Time-Dependent States and Spectroscopy:** Absorption and Emission of radiation. Selection rules. Line shapes and widths. Fourier Transform spectroscopy.
2. **Rotation and Vibration of Diatomic Molecules:** Rigid Rotor and harmonic oscillator wave functions and energies. Selection rules. A review of MW and IR spectroscopy. Diatomic molecule wave functions- symmetry properties and nuclear spin effects. Raman effect: Rotational and vibration-rotational transitions. Polarization of Raman lines. Vibration of polyatomic molecules –normal coordinates.
3. **Electronic Spectroscopy :** Electronic spectroscopy of diatomic molecules. Franck-Condon factor. Dissociation and pre-dissociation. Rotational fine structure. Lasers and Laser spectroscopy.
4. **Magnetic Resonance :** Review of angular momentum. Commutation relations. Basic principles and relaxation times. Magnetic resonance spectrum of hydrogen. First-order hyperfine energies. NMR in liquids: Chemical shifts and spin-spin couplings. First order Spectra: A_3X, AX and AMX systems. Second order spectra: AB system. Equivalent nuclei. A_2B_2 system
5. **CW NMR :** The spectrometer. Multiscan Principle (CAT)
6. **FT NMR :** Rotating frame of reference. Effect of rf pulse. FID. Multipulse operation. Measurement of T_1 by inversion recovery method. Spin echo and measurement of T_2

Book Recommended

1. J. M. Hollas, *Modern Spectroscopy*, 4th edition (2004) John Wiley & Sons, Ltd., Chichester.
2. C. N. Banwell and E.M. Mc Cash, *Fundamentals of Molecular Spectroscopy*, 4th edition (1994), Tata McGraw Hill, New Delhi.
3. A Carrington and A. D. Mc Lachlan, *Introduction to Magnetic Resonance*, (1979) Chapman and Hall, London.
4. R. K. Harris, *Nuclear Magnetic Resonance Spectroscopy*, (1986) Addison Wesley, Longman Ltd, London.
5. G. Herzburg, *Infrared and Raman Spectra* (1945), *Spectra of Diatomic Molecules* (1950), Van Nostrand, New York.

MCH-426 : BIOLOGICAL CHEMISTRY

40 Lectures

1. **Nucleic Acids**: RNA, DNA, base-pairing, double helical structure of DNA, Gene regulatory protein- Zinc finger protein.

2. **Lipids and membranes**: Classification of lipids, self association of lipids-micelles, reverse micelles and membranes, transport of cations through membranes.
3. **Carbohydrates** : Oligosaccharides and polysaccharides, role of sugars in biological recognition.
4. **Metabolism and Energetics**: Catabolic and anabolic processes, glycolysis, citric acid cycle and oxidative phosphorylation.
5. **Enzyme**: Enzyme kinetics and applications of enzymes in organic synthesis.
6. **Metalloenzymes of copper and zinc :** Superoxide dismutase, carbonic anhydrase and carboxy-peptidase.
7. **Oxygen uptake proteins :** With special reference to hemerythrin and hemocyanin.
8. **Molecular recognition :** Chiral recognition, supramolecular chemistry, and hydrogen bonding in molecular organization.

Books Recommended

1. L. Stryer, *Biochemistry*, 5th edition (2002), Freeman & Co., New York.
2. D. L. Nelson and M.M. Cox, *Lehninger Principles of Biochemistry*, 3rd edition (2002) McMillan North Publication.
3. M. N. Hughes, *Inorganic Chemistry of Biological Processes*, (1981) John Wiley.
4. M.B. Smith, *Organic Synthesis*, (1995) McGraw Hill Inc., New York.

M.Sc. (Final)

III SEMESTER

MCH-531 : SOLID STATE CHEMISTRY

40 Lectures

1. **Solid State Reactions :** General Principles, Experimental procedure, Co-precipitation, Kinetics of solid state reactions, Crystallization of solutions, melts, glasses and gels. Growth of single crystals: Czochralski method, Bridgman and Stockbarger methods. Zone Melting.
2. **X-ray Diffraction & Crystal Structure :** Diffraction of X-rays by crystals: The Laue equations and Bragg's law. Definitions related to crystal structure. X-ray diffraction experiments: the powder method and the single crystal method. Reciprocal lattice. Structure factor. Structure factor and intensity. Electron density maps.
3. **Phase Transitions :** Thermodynamic and Burger's classification of phase transition, Kinetics of phase transition- nucleation and growth, T-T-T diagrams, Factors that influence kinetics of phase transition, Martensitic and order-disorder transitions.
4. **Electronic Properties and Band Theory :** Electronic structure of solids- band theory, Refinement to simple band theory- k-space and Brillouin Zones, Band structure of metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, Doped semiconductors, p-n junctions.

5. **Magnetic Properties :** Classification of materials: Quantum theory of paramagnetics. Cooperative phenomena. Magnetic domains. Hysteresis.

Books Recommended

1. A.R. West, *Solid State Chemistry and its Applications*, (1984) John Wiley and Sons, Singapore.
2. L.V. Azaroff, *Introduction to Solids,* (1977) Tata McGraw-Hill, New Delhi.

Major Electives I-III

Analytical Chemistry Specialization

MCH-532(A) : PRINCIPLES OF ANALYTICAL CHEMISTRY

40 Lectures

1. **Chemical Instrumentation :** Elementary Electronics, Simple integrated circuit, Semiconductor, Power supply, transformer, operational amplifier, Detectors (Oscilloscope and recorders), transducers, Rectifiers, Signal to noise ratio, Electronic components (Resistors, capacitors, inductors, transistors), Measuring instruments for pressure, temperature, pH, speed, flow, current and voltage.
2. **Acid Base Equilibria :** General concept of acid-base equilibria in water and in non-aqueous solvent, Definition of pH and pH scale (Sörenson and operational definitions), and its significance, Hammett acidity function, pH calculation for aqueous solutions of very weak acid and very weak base, salts of weak acid and weak bases, mixture of weak acid and its salts, mixture of weak base and its salts, polybasic acids and their salts, polyamines and amino acid, comparison of solution of polybasic acid as a function of pH, protolysis curves.
3. **Buffer Solutions :** Theory of buffer solution, dilution and salts effects on the pH of a buffer, Buffer index, Criteria and expression of maximum buffer capacity, Application of pH buffers, Preparation of buffer solutions of known ionic strength (Typical examples). Practical limitations in use of buffers, Metal ion buffers and their applications, Biological buffers and their applications.
4. **Photometric Titrations :** Basic principles, comparison with other titrimetric procedures, types of photometric titration curves, Instrumentation (Titration cell, Detectors, choice of analytical wavelength). Quantitative applications, Typical examples of one component and multicompo-nent analyses.

Books Recommended

1. D.A. Skoog and D.M. West, *Fundamental of Analytical Chemistry*, International Edition, 7th Edition (1996), Saunders College Publishing, Philadelphia, Holt, London.
2. R.L. Pecsok, L.D. Shields, T. Cairns and L.C. McWilliam, *Modern Methods of Chemical Analysis*, 2nd (1976), John Wiley & Sons, New York.

3. D.A. Skoog, *Principles of Instrumental Analysis*, 5th Edition (1998), Saunders College of Publishing, Philadelphia, London.
4. H.A. Strobel, *Chemical Instrumentation: A Schematic Approach*, 2nd Edition (1973), Addison Wesley, Reading, Mass.

Additional References

1. H.A. Laittnen and W.E. Harris, *Chemical Analysis*, 2nd International Student Edition (1960), McGraw Hill, New York.
2. R.G. Bates, *Electrometric pH Determinations: Theory and Practice*, 3rd Edition (1973), John Wiley & Sons, New York.
3. G.D. Moody and J.D.R. Thomas, *Ion-selective Electrodes*, London.
4. G.W. Ewing, *Instrumental Methods of Chemical Analysis*, 5th Edition (1978), McGraw Hill Book Co., New York.

MCH-533(A) : SPECTROCHEMICAL ANALYSIS

40 Lectures

1. **Infrared Spectroscopy :** Infrared sources and transducers, Infrared instruments, Typical applications of infrared spectroscopy (qualitative and quantitative).
2. **Raman Spectroscopy :** Theory of Raman spectroscopy, Instrumentation, Analytical applications of Raman spectroscopy.
3. **Nuclear Magnetic Resonance Spectroscopy :** Theory of nuclear magnetic resonance, Environmental effects on NMR spectrometers, Applications of proton NMR, C^{13} NMR, Two dimensional Fourier-transform NMR, Magnetic resonance imaging (MRI), Quantitative applications of NMR: Drug Analysis, Molecular Weight determination.
4. **Electron Spin Resonance Spectroscopy :** Theory, Instrumentation and Important analytical applications.
5. **Electron Spectroscopy :** Theory, Instrumentation and applications of Electron spectroscopy (ESCA and Auger), Scanning electron microscopy (SEM), Scanning tunnelling microscopy (STM) and Atomic force microscopy (AFM).
6. **Plasma Emission Spectroscopy :** Theory, Instrumentation and Analytical applications of Inductively coupled plasma emission spectroscopy (ICPE).
7. **Polarimetry :** Polarimetry, Spectropolarimetry, Optical rotatory dispersion and Circular dichroism.

Books Recommended

1. D.A. Skoog, F.J. Holler and T.A. Nieman, *Principles of Instrumental Analysis*, 5th Edition (1998), Harcourt Brace & Company, Florida.

2. R.L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, *Modern Methods of Chemical Analysis*, 2nd Edition (1976), John Wiley, New York.

3. J.M. Hollas, *Modern Spectroscopy*, 3rd Edition (1996), John Wiley, New York.

4. H.A. Strobel, *Chemical Instrumentation - A Systematic Approach*, 2nd Edition (1973), Addison Wesley, Mass.

MCH-534(A) : MICROANALYTICAL TECHNIQUES

40 Lectures

1. **General Introduction :** Scope and objectives of microanalytical technique, Difference between micro and trace analysis, Microanalytical technique based on size and amount of the sample.

2. **Microanalysis of real-world Samples :** Molecular recognition and targetted analysis using macrocyclic (crown ethers), macrobicyclic (cryptands), Supramolecular compounds (calixarenes) and polymeric materials.

3. **Biochemical Microanalysis :** Estimation of carbohydrates, amino acids and ascorbic acid in biological systems, Estimation of protein in egg albumin, Estimation of free fatty acid, Iodine value and saponification value of fats/oils, Estimation of blood cholesterol, DNA and RNA.

4. **Inorganic microanalysis :** Principle, Technique, qualitative and quantitative applications with special reference to Ring-oven technique and Ring colorimetric technique, Chemical microscopy.

5. **Organic Microanalysis :** Determination of alkoxy, acetyl, acyl, hydroxyl, carbonyl, active hydrogen, nitroso, sulfonyl, amides and ester groups, Determination of molecular weight and percentage purity of carboxylic acid, Estimation of sugars, Estimation of unsaturation.

6. **Microanalysis by Kinetic Methods :** Theoretical basis, Kinetic parameters, Kinetic methods of microanalysis: Tangent, fixed time and addition method.

Books Recommended

1. P.L. Kirk, *Quantitative Ultramicroanalysis*, John Wiley.

2. C.L. Wilson and D.L. Wilson, *Comprehensive Analytical Chemistry"*, Vol. I(A) and I(B), Elsevier.

3. G.D. Christian , *Analytical Chemistry*, (2001) John Wiley & Sons, New York.

4. S.M. Khopkar, *Analytical Chemistry of Macrocyclic and Supramolecular Compounds*, (2002) Narosa Publishing House, New Delhi.

5. Jag Mohan, *Organic Analytical Chemistry - Theory and Practice*, (2003) Narosa Publishing House, New Delhi.

Inorganic Chemistry Specialization

MCH-532(I) : ORGANOMETALLIC CHEMISTRY OF TRANSITION METALS

40 Lectures

1. **Metal Carbonyls :** Semibridging carbonyl group; metal nitrosyl carbonyls; tertiary phosphines and arsines as ligands; carbenes and carbynes.
2. **π-Complexes of Unsaturated Molecules :** Preparation, bonding and structures of alkene, alkyne, allyl, dienyl and trienyl complexes; reactions with special reference to organic synthesis.
3. **Transition Metal Compounds in Homogeneous Catalysis :** Hydrogenation, hydroformylation and polymerization; Waker process.
4. **Transition Metal Compounds with M-H bonds**.

Books Recommended

1. F. A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry*, 6th Edn., (1999), John-Wiley & Sons, New York.
2. James E. Huheey, *Inorganic Chemistry*, 4th Edn., (1993), Addison Wesley Pub. Co., New York
3. R.H. Crabtree, *The Organometallic Chemistry of the Transition Metals*, 1st Edn.(1988), John-Wiley & Sons, New York.
4. J. P. Collman, L. S. Hegedus, J. R. Norton and Richard G. Finke, *Principles and Applications of Organotransition Metal Chemistry*, 1st Edn.(1987), University Science Books, Mill Valley, California.

MCH-533(I) : BIO-INORGANIC CHEMISTRY

40 Lectures

1. **Role of alkaline earth metal ions in biological systems :** (i) Catalysis of phosphate transfer by Mg^{2+} ion, (ii) Ubiquitous regulatory role of Ca^{2+} - muscle contraction.
2. **Iron, copper and molybdenum proteins with reference to their oxygenation and oxidase activity :** (i) Anti-oxidative functions (cytochrome P-450, catalases and peroxidases), (ii) Nitrate and nitrite reduction (NO_3^- and NO_2^- reductase), (iii) Electron transfer (cytochromes, blue copper proteins and iron-sulfur proteins), (iv) Synthetic models of iron-sulfur proteins, (v) molybdo-enzymes – molybdenum cofactors (molybdenum-pterin complexes), (vi) nitrogen fixation through metal complexation–nitrogenase, (vii) Photosynthesis (PS-I and PS-II).
3. **Metalloenzymes :** urease, hydrogenase, and cyanocobalamine.
4. **Interaction of metal complexes with DNA :** DNA probe and chemotherapeutic agents.
5. **Iron storage and transport proteins :** Ferritin, transferritin and hemosiderin.

Books recommended

1. M. N. Hughes, *Inorganic Chemistry of Biological Processes*, 2nd Ed.(1981), John-Wiley & Sons, New York.
2. W. Kaim and B. Schwederski, *Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life, An Introduction and Guide*, (1995) Wiley, New York.
3. S. J. Lippard and J. M. Berg, *Principles of Bioinorganic Chemistry*, (1994) University Science Books.
4. I. Bertini, H. B. Grey, S. J. Lippard and J. S. Valentine, *Bioinorganic Chemistry*, (1998) Viva Books Pvt. Ltd., New Delhi.

MCH-534(I) : STRUCTURAL METHODS IN INORGANIC CHEMISTRY

40 Lectures

1. **NMR Spectroscopy :** (i) Use of Chemical shifts and spin-spin couplings for structural determination, (ii) Double resonance, and Dynamic processes in NMR, (iii) Decoupling phenomenon, Nuclear Overhauser Effect, DEPT spectra and structural applications in ^{13}C NMR, (iv) Lanthanide shift reagents, (v) ^{1}H NMR of paramagnetic substances.
2. **Electron Spin Resonance Spectroscopy :** Basic principle, Hyperfine splittings (isotropic systems); the *g*-value and the factors affecting thereof; interactions affecting electron energies in paramagnetic complexes (Zero-field splitting and Kramer's degeneracy); Anisotropic effects (the *g*-value and the hyperfine couplings); The EPR of triplet states; Structural applications to transition metal complexes.
3. **Mössbauer Spectroscopy :** Basic principle, conditions for Mossbauer spectroscopy, Spectral parameters (Isomer shift, electric quadrupole interactions, magnetic interactions), temperature-dependent effects, structural deductions for iron and tin complexes, miscellaneous applications.
4. **Infrared and Raman Spectroscopy :** Comparison of IR and Raman spectroscopies; applications of vibrational spectroscopy in investigating (i) symmetry and shapes of simple AB_2, AB_3 and AB_4 molecules on the basis of spectral data, (ii) mode of bonding of ambidentate ligands (thiocyanate, nitrate, sulphate and urea).
5. **Mass Spectrometry :** Fingerprint applications and the interpretation of Mass spectra, effect of isotopes on the appearance of mass spectrum, recognition of the molecular ion peak; Ionization techniques (EI and FAB)

Books Recommended

1. E. A. V. Ebsworth, D. W. H. Rankin and S. Cradock, *Structural Methods in Inorganic Chemistry*, 1st Edn.(1987), Blackwell Scientific Publications, Oxford, London.
2. R. S. Drago, *Physical Methods for Chemists,* (1992), Saunders College Publishing, Philadelphia.

3. R. S. Drago, *Physical Methods in Inorganic Chemistry*, 1st Edn.(1971), Affiliated East-West Press, New Delhi.

4. K. Nakamoto, *Infrared and Raman Spectra of Inorganic and Coordination Compounds*, 4th Edn. (1986), John Wiley & Sons, New York.

5. W. Kemp, *Organic Spectroscopy*, 3rd Edn. (1991), MacMillan, London.

6. G. Aruldhas, *Molecular Structure and spectroscopy*, (2001) Prentice Hall of India Pvt. Ltd., New Delhi.

Organic Chemistry Specialization

MCH-532(O) : Application of Spectroscopy to Structural Analysis

40 Lectures

1. **Ultra-Violet Spectroscopy :** Absorption of dienes, polyenes, carbonyl compounds and α,β-unsaturated carbonyl compounds. Woodward rule and its application. Aromatic compounds.

2. **Infrared Spectroscopy :** Vibration modes and bond stretching. Absorption of common functional groups, electrical and steric effects, effects of Hydrogen bonding. Fingerprint region and interpretation of IR spectra.

3. **PMR Spectroscopy :** Interpretation of spectra, chemical shift, shielding mechanism and anisotropic effects, chemical exchange and chemical shifts in chiral molecules. Spin-spin interactions, naming spin systems, magnitude of coupling constant: geminal, vicinal and long range couplings. Second order spectrum and analysis of AB, AMX and ABX systems. Simplification of Complicated Spectra: Aromatic induced shifts, spin decoupling, deuterium exchange, spectra at higher fields. Hindered rotation and rate processes.

4. **CMR Spectroscopy :** General considerations, chemical shift, coupling constants. Nuclear Overhauser effect. Spin-spin, spin-lattice relexations. Off resonance decoupling. DEPT. Interpretation of simple CMR spectra. 2 DNMR: COSY, NOESY and HETCOR.

5. **Mass Spectrometry :** Introduction, ion production, fragmentation, factors influencing ion abundance, single and multiple bond cleavage, rearrangements, cleavage associated with common functional groups, molecular ion peak, metastable ion peak, Nitrogen rule and interpretation of mass spectra.

6. **Problems :** Structure elucidation based on spectroscopic data.

Book Recommended

1. J.R. Dyer, *Application of Absorption Spectroscopy of Organic Compounds,* Prentice Hall, New Delhi (1978).

2. R.M. Silverstein and F.X. Webster, *Spectroscopic Identification of Organic Compounds*, 6th Edition (2003) John Wiley, New York.

3. D.H. Williams and I.F. Fleming, *Spectroscopic Methods in Organic Chemistry*, 4th Edition (1988), Tata-McGraw Hill, New Delhi.

4. P.Y Bruice, *Organic Chemistry*, 2nd Edition (1998) Prentice – Hall, New Delhi.

MCH-533(O) : REACTION MECHANISM AND STEREOCHEMISTRY

40 Lectures

1. **Neighbouring Group Participation :** Evidences of N.G.P., the phenoniumion, participation by π and σ bonds, Anchimeric assistance. Classical versus non-classical carboniumions -- the present status.

2. **Kinetic Isotope Effects :** Its origin and importance in determining reaction mechanism. Solvent isotope effects.

3. **Stereochemistry :** (a) General consideration of molecular asymmetry and dissymmetry(b) Configuration--absolute and relative, methods of determination; (i) Chemical transformation, (ii) Asymmetric synthesis : Chiral auxiliaries, Chiral reagents and catalysts, Enantiomeric excess (iii) Quasiracemates. (c) Atropisomerism of biphenyls. **Conformation**--conformational analysis based on physical properties and chemical reactivity, shape of six membered ring, conformation and reactivity in cyclohexanes and decalins.

4. **Rearrangements :** Sommelet-Hauser, Favorskii, Fries and Benzilic acid rearrangements. Hofmann-Loffler-Freytag reaction, Barton reaction and Shapiro reaction.

Books Recommended

1. E.S. Gould, *Mechanism & Structure in Organic Chemistry*, (1963) Holt, Rinehart & Winston, New York.

2. M.B. Smith and J. March, *March's Advanced Organic Chemistry-Reactions, Mechanisms and Structure*, 5th Edition (2001), John Wiley & Sons, New York.

3. D. Nasipuri, *Stereochemistry of Organic Compounds*, 2nd Edition (1994), Wiley Eastern Ltd., New Delhi.

4. E.L. Eliel and S.H. Wilen, *Stereochemistry of Organic Compounds*, (1994) Wiley Interscience, New York.

5. Paul de Mayo, *Molecular Rearrangements*, (1963) Vol. I & II, Interscience Publishers, New York.

6. J. Aube and R. E. Gawley, *Principles of Asymmetric Synthesis.*

MCH- 534(O) : NATURAL PRODUCTS

40 Lectures

1. **Alkaloids :** Structure elucidation of alkaloids – a general account; Structure, synthesis, and stereochemistry of Narcotine and Quinine; synthesis and stereochemistry of Morphine, Lysergic acid and Reserpine.
2. **Terpenoids :** Camphor, Longifolene*, Abietic acid, and Taxol.
3. **Steroids :** Cholesterol, Cortisone*, and Aldosterone*.
4. **Prostaglandins and Thromboxanes :** Introduction, nomenclature of prostaglandins and thromboxanes; approaches to prostaglandin synthesis; cyclohexane precurors (Woodward synthesis of $PGF_2\alpha$), bicycloheptane precursors (Corey's synthesis of prostaglandins E and F)
5. **Retrosynthetic Analysis of some typical Natural Products.**

---

* Synthesis only.

Books Recommended

1. Nitya Anand, J.S. Bindra and S. Ranganathan, *Art in Organic Synthesis*, 2nd Edition (1970), Holden Day, San Francisco.
2. S.W. Pelletier, *Chemistry of the Alkaloids*, (1970) Van Nostrand Reinhold Co., New York.
3. K.W. Bentley, *The Alkaloids*, Vol. I., (1957) Interscience Publishers, New York.
4. I. L. Finar, *Organic Chemistry*, Vol. II, 5th Edition (1975) Longman Ltd, New Delhi.
5. J.W. Apsimon, *Total Synthesis of Natural Products*, Vol. 1-6, Wiley-Interscience Publications, New York.
6. J.S. Bindra and R. Bindra , *Creativity in Organic Synthesis*.
7. J.S. Bindra and R. Bindra, *Prostaglandins Synthesis*.
8. S. Warren, *Organic Synthesis: Disconnection Approach,* (1982) Wiley, New York.
9. K. C. Nicolaou, *Classics in Total Synthesis of Natural Products,* Vol. I & II.
10. J. Clayden, N. Greeves, S. Warren, and P. Wothers, *Organic Chemistry, Chapter 30,* (2001) Oxford University Press, Oxford.

Physical Chemistry Specialization

MCH-532(P) : ELECTROCHEMISTRY

40 Lectures

1. **Activity Coefficient and Ionic Migration in Electrolyte Solutions :** Quantitative treatment of Debye-Hückel theory of ion-ion interaction and activity coefficient, applicability and limitations of Debye-Hückel limiting law, its modification for finite-sized ions, effect of ion-solvent interaction on activity coefficient. Debye-Hückel-Onsagar (D-H-O) theory of conductance of electrolyte solution, its applicability and limitations, Pair-wise association of ions (Bjerrum and Fuoss treatment), Modification of D-H-O theory to account for ion-pair formation, Determination of association constant (K_A) from conductance data.

2. **Electrical Double Layer at Metal/Semiconductor-Electrolyte Interface :** Thermodynamics of double layer, Electrocapillary equation, Determination of surface excess and other electrical parameters- electrocapillarity, excess charge capacitance, and relative surface excesses. Metal/ water interaction- Contact adsorption, its influence on capacity of interface, Complete capacity-potential curve, Constant capacity region hump. Specific adsorption- extent of specific adsorption, Adsorption isotherm, rate of adsorption, Semiconductor/ electrolyte interface, Capacity of space-charge, Mott-Schottky plot.

3. **Electrode Kinetics :** Review of Butler-Volmer treatment. Polarizable and non-polarizable interfaces. Multistep reactions- a near equilibrium relation between current density and over potential, Concept of rate determining step. Determination of reaction order. stochiometric number, and transfer coefficient. Electrocatalysis--comparison of electrocatalytic activity. Importance of oxygen reduction and hydrogen evolution reactions and their mechanisms.

Books Recommended

1. J.O'M. Bockris and A.K.N. Reddy, *Modern Electrochemistry*, Vol. 1 & 2A and 2 B, (1998) Plenum Press, New York.

MCH: 533(P) : CHEMICAL KINETICS

40 Lectures

1. **Experimental Techniques for Fast Reaction :** Flow techniques, relaxation methods, flash photolysis.

2. **Transition State Theory :** Application of statistical mechanics to transition state theory, Comparison of transition state theory with experimental results. Thermodynamic treatment of TST. Theories of unimolecular reactions--treatments of Lindmann, Hinshelwood, Rice-Ramsperger-Kassel (RRK), and Rice- Ramsperger-Kassel-Marcus (RRKM).

3. **Reactions in Solution :** Reaction between ions; Effect of solvent (single & double sphere models), interpretation of frequency factor and entropy of activation, influence of ionic strength, salt effect

and reaction mechanisms. Reactions involving dipoles. Influence of pressure on reaction rates in solution. Significance of value of activation. Influence of substituents on reaction rates. Electronic theories of organic reactivity. Linear free energy relationships. The Hammett equation, significance of σ and ρ. The Taft equation.

4. **Homogeneous Catalysis :** General catalytic mechanism, Mechanism of acid-base catalysis (protolytic and prototropic). Bronsted catalytic law.

5. **Kinetics of Polymerisation Reactions :** Condensation and Addition (free radical, ionic, co-ordination) Polymerisation. Co-polymerisation.

Books Recommended

1. M. J. Pilling and A.P.W, Seakins, *Reaction Kinetics*, (1998) Oxford Science Publication, New York.
2. K.J. Laidler, *Chemical Kinetics*, 3rd Edition (1967), Harper & Row Publishers, New York.
3. J. Rajaram and J.C. Kuriacose, *Kinetics and Mechanism of Chemical Transformation*, Ist Edition (1993), MacMillan India Ltd., New Delhi.
4. B. G. Cox, *Modern Liquid Phase Kinetics*, (1994) Oxford University Press, Oxford.

MCH-534(P) : QUANTUM CHEMISTRY

40 Lectures

1. **Fundamentals :** Review of Classical Mechanics. General formulation of Qunatum Mechanics. Theory of angular momentum. Angular momentum of composite systems. Review of rigid rotor, harmonic oscillator and H- atom problems.

2. **Approximation Methods :** Stationary perturbation theory for non-degenerate and degenerate systems with examples. Variation method. Ground state of He atom. Time-dependent perturbation theory. Radiative transitions. Einstein coefficients.

3. **Group Theory :** Review and applications.

4. **Tunneling Problem :** Tunneling through a rectangular barrier. Application examples.

5. **Ab initio and Semi-empirical Methods for Closed Shell Systems :** Roothaan-Hartree-Fock method. Selection of basis sets. Semiempirical methods. Density functional theory.

Books Recommended

1. P.W. Atkins and R.S. Friedman, *Molecular Quantum Mechanics,* 3rd edition (1997), Oxford University Press. Oxford.
2. H. Eyring, J.Walter and G.E. Kimball, *Quantum Chemistry,* (1944) John Wiley, New York.
3. I.N. Levine, *Quantum Chemistry*, 5th edition (2000), Pearson Educ., Inc., New Delhi.

IV SEMESTER

MCH-541 : ENVIRONMENTAL CHEMISTRY

40 Lectures

1. **Introduction to Environmental Chemistry :** Concept and scope of environmental chemistry, Environmental terminology and nomenclatures, Environmental segments, The natural cycles of environment (Hydrological, Oxygen, Nitrogen, Phosphorous and Sulphur cycles).

2. **Atmosphere :** Regions of the atmosphere, Reactions in atmospheric chemistry, Earth's radiation balance, Particles, ion and radicals in the atmosphere, stratospheric chemistry: The chemistry of ozone layer, The role of chemicals in ozone destruction, The green-house effect and Global warming, El-Nino phenomenon.

3. **Hydrosphere :** Complexation in natural water and waste-water, Micro-organism in aquatic chemical reactions, Eutrophication, Re-cycle of waste-water in process industry, Treatment of sewage and reuse of water in industry and agriculture, Microbiologically mediated redox reactions and Nitrogen transformation by bacteria.

4. **Lithosphere :** The terrestrial environment, Soil formations, Soil properties (physical/chemical), inorganic and organic components in soil, acid-base and ion-exchange reactions in soil, micro and macro nutrients, nitrogen pathways and NPK in soil, waste and pollutants in soil, waste classification and disposal.

5. **Chemical Toxicology :** Toxic chemicals in the environments, Impact of toxic chemicals on enzymes, Biochemical effects of arsenic, cadmium, lead, mercury, carbon monooxide, nitrogen oxides, sulphur oxides, ozone, PAN, cyanide, pesticides, insecticides and carcinogens.

6. **Air Pollution :** Air pollutants (sources, classification, sampling and monitoring): Particulates, Aerosols, SO_x, NO_x, CO_x and hydrocarbon emission, Photochemical smog, Autoexhausts, Acid-rains, Air-quality standards.

7. **Water Pollution :** Water pollutants (sources, sampling and monitoring), Water-quality parameters and standards: physical and chemical parameters (colour, odour, taste and turbidity), Dissolved oxygen, BOD, COD, Total organic carbon, Total nitrogen, Total sulfur, Total phosphorus and Chlorine, Chemical speciation.

8. **Environmental Management :** Methods of environmental management, Radio active waste management, Environmental impact assessment, Natural resources of energy-consumptions and conservation.

Books Recommended

1. G.W. Vanloon, S.J. Duffer, *Environmental Chemistry - A Global Perspective*, (2000) Oxford University Press.
2. F.W. Fifield and W.P.J. Hairens, *Environmental Analytical Chemistry*, 2nd Edition (2000), Black Well Science Ltd.

3. Colin Baird, *Environmental Chemistry*, (1995) W.H. Freeman and Company, New York.
4. A.K. De, *Environmental Chemistry*, 4th Edition (2000), New Age International Private Ltd., New Delhi.

Additional References

1. Peter O. Warner, *Analysis of Air Pollutants,* 1st Edition (1996), John Wiley, New York.
2. S.M. Khopkar, *Environmental Pollution Analysis,* 1st Edition (1993), Wiley Estern Ltd., New Delhi.
3. S.K. Banerji, *Environmental Chemistry,* 1st Edition (1993), Prentice-Hall of India, New Delhi.

MCH-542 : COMPUTER APPLICATIONS IN CHEMISTRY

25 Lectures

1. **FORTRAN 77 :** Types of Constants and Variables in Fortran, Dimension, Data, Type, COMMON and EQUIVALENCE statements, Arithmetic and Logical IF, IF-THEN-ELSE Constructs, DO statement, Various types of I/O statements, Library functions, Statement functions, Function subprograms and subroutine subprograms with suitable examples.

2. **Numerical Methods :**

   Roots of Polynomials, Solution of Linear simultaneous equations, matrix multiplication and inversion. Numerical integration.

   Statistical treatment of data, variance and correlations, Least square curve fitting.

Books Recommended

1. V. Rajaraman, *Fortran 77*, Prentice Hall (India), New Delhi.
2. S.D. Conte and C. deBoor, *Elementary Numerical Analysis,* McGraw-Hill (Intl. Edition) (1987).
3. K. V. Raman, *Computers in Chemistry,* Tata McGraw Hill (1993).

Major Electives IV & V

Analytical Chemistry Specialization

MCH-543(A) : SEPARATION TECHNIQUES

40 Lectures

1. **Separation Techniques Based on Phase Equilibria :** Principles of analytical separation: Plate theory, rate theory, Craig concept of counter current distribution, process optimisation, Retention analysis; Resolution (Fundamental equation). Distillation: Fractional distillation, Molecular distillation. Chromatography: Gas chromatography, Liquid chromatography (including high performance chromatography), Ion-exchange chromatography, Ion chromatography, Size exclusion

chromatography, Planar chromatography (PC, TLC, HPTLC), Reverse phase chromatography & Bonded phase chromatography (BPC), Super critical fluid chromatography (SFC). Solvent Extraction: Liquid-Liquid and super critical fluid extraction, Quantitative treatment of various Solvent, extraction equilibria. Sublimation: Normal and vacuum sublimation. Crystallisation: Zone refining and Fractional.

2. **Separation Techniques Based on Rate Processes :** (a) Barrier-separation methods: Membrane separation-Ultrafiltration, dialysis, electrodialysis, electro-osmosis, reverse osmosis, (b) Field separation methods: Electrophoresis, Ultracentri-fugation.

Books Recommended

1. G.H. Morrison and H. Freiser, *Solvent Extraction in Analytical Chemistry*, 1st Edition (1958), John Wiley, New York.
2. B.L. Karger, L.R. Snyder and C. Howarth, *An Introduction to Separation Science*, 2nd Edition (1973), John Wiley, New York.
3. E.W. Berg, *Chemical Methods of Separation*, 1st Edition (1963), McGraw Hill, New York.
4. D.G. Peters, J.M. Hayes and C.M. Hieftj, *Chemical Separation and Measurements*, 2nd Edition (1974), Saunders Holt, London.
5. J.D. Seader and E.J. Henley, *Separation Process Principles*, 1st Edition (1998), John Wiley & Sons. Inc., New York.

MCH-544(A) : ELECTROANALYTICAL METHODS

40 Lectures

1. **General Introduction :** Overviews of Electrode Processes, Electrocapillary curve and electrocapillary maximum potential, Exchange current, Polarisation and overvoltage, Reference electrodes. Mercury electrodes (DME, SME, HMDE), Rotating platinum electrode. Three electrode system.

2. **Polarography :** Origin of polarography, Interpretation of a polarographic curve. Instrumentation. Limiting current, residual and charging current, diffusion current, migration current. Supporting electrolytes. Effect of supporting electrolyte on the limiting current. Diffusion coefficient and its evaluation. Ilković equation, its derivation and applications. Estimation of n-value(s). Theory and equations of different current-potential curves. Criteria of polarographic reversibility. Quasi-reversible and irreversible processes. Half-wave potentials and their significance. Interpretation of catalytic, kinetic, adsorption and capacitive currents. Polarographic maxima and maximum suppresors. Methods of quantitative analysis: absolute, comparative, the PILOT ION and kinetic methods.

3. **Modern Polarography :** Necessity and development of new voltammetric techniques and their comparison with classical polarography. Fundamentals of sampled DC polarography (Tast),

oscilliography, differential and derivative voltammetry, cyclic, pulse, alternating current and square wave polarography.

4. **Related Techniques :** Amperometric titration, Chronoamperometry, Chronopotentiometry. Controlled-potential and constant current coulometry. Stripping analysis, Electrogravimetry, Electrography and Electro-spot testing.

Books Recommended

1. L. Meites, *Polarographic Techniques*, 2nd Edition (1965), John Wiley, New York.
2. J. Heyrovsky and K. Kuta, *Principles of Polarography*, 1st Edition (1966), Academic Press, New York.
3. D.A. Skoog, F.J. Holler and T.A. Nieman, *Principles of Instrumental Analysis*, 5th Edition (1998), Saunders College Publishing, Harcourt Brace & Company, U.S.A.
4. A.J. Bard and L.R. Faulkner, *Electrochemical Methods: Fundamentals and Applications*, 2nd Edition (2000), Wiley, New York.

Additional References

1. I.M. Kolthoff and J.J. Lingane, *Polarography*, 2nd Edition (1952), Wiley Intersciences, New York.
2. C.W.C. Milner and G. Phillips, *Coulometry in Analytical Chemistry*, (1967) Pregamon Press, New York.

Inorganic Chemistry Specialization

MCH-543(I) : INORGANIC RINGS, CHAINS, AND CLUSTERS

40 Lectures

1. **Isopoly and Heteropoly Acids and Salts :** Synthesis and structural principles with reference to those of V, Nb, Ta, Cr, Mo and W.
2. **Metal Clusters and Metal-Metal Bonds :** Compounds with metal-metal multiple bonds, metal carbonyl and halide clusters.
3. **Polyhedral Boranes :** Higher boranes, carboranes, metallo-boranes and metallo-carboranes – Structure and Bonding.
4. **Parallels between main group and Organometallic Chemistry :** Isolobal concept (Hoffman) in organometallic and metal-cluster chemistry.
5. **Inorganic Polymers :** Classification, Types of Inorganic Polymerization, Comparison with organic polymers, Boron-oxygen and boron-nitrogen polymers, silicones, coordination polymers, sulfur-nitrogen, sulfur-nitrogen-fluorine compounds, chalcogenide clusters – binary and multi-component systems, homolytic inorganic systems.

Books Recommended

1. F. A. Cotton and G. Wilkinson *Advanced Inorganic Chemistry*, 6th Edn. (1999), John-Wiley & Sons, New York.
2. James E. Huheey, *Inorganic Chemistry*, 4th Edn. (1993), Addison Wesley Pub. Co., New York
3. N. N. Greenwood and A. Earnshaw, *Chemistry of the Elements*, 2nd Edn. (1997), Butterworth Heinemann, London.
4. Gary L. Miessler and Donald A. Tarr, *Inorganic Chemistry*, 2nd Edn.(1999), Prentice Hall International Inc., London.

MCH-544(I) : SPECIAL TOPICS IN INORGANIC CHEMISTRY

40 Lectures

1. **Macrocyclic Complexes :** Types of macrocyclic ligands – design and synthesis by coordination template effect, di- and poly-nuclear macrocyclic complexes; applications of macrocyclic complexes.
2. **Supramolecular Chemistry :** Concept of supramolecular chemistry, molecular recognition, nomenclature, design of supramolecular through non-covalent interactions and their applications in transport processes.
3. **Molecular Magnetic Materials :** Basic concepts of molecular magnetism, types of magnetic interactions, recent techniques of magnetic susceptibility measurements, inorganic and organic ferro-magnetic materials, low-spin – high-spin transitions, isotropic interactions in dinuclear compounds (dipolar, anisotropic and anti-symmetric interactions), trinuclear compounds and compounds of high nuclearity, magnetic chain compounds, magnetic long-range ordering in molecular compounds: design of molecular magnets, physical investigations and applications.
4. **Metallomesogens :** Basic concepts, types of meso-phases, synthetic strategies, characterization and applications.

Books Recommended

1. Jean-Marie Lehn, *Supramolecular Chemistry*, (1995) VCH, Weinheim.
2. J. L. Serrano, *Metallomesogens*, (1996) VCH, Weinheim.
3. Oliver Kahn, *Molecular Magnetism*, (1993) VCH, Weinheim.
4. F.A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann, *Advanced Inorganic Chemistry*, 6th Edn., (2003) John Wiley & Sons (Asia), Singapore.

Organic Chemistry Specialization

MCH-543(O) : REAGENTS AND ORGANIC SYNTHESIS

40 Lectures

1. **Reduction :** (i) Complex metal hydride reductions: $LiAlH_4$ and $NaBH_4$; reduction of aldehydes and ketones, stereochemistry of ketone reduction, (ii) Reduction of conjugated systems: Birch reduction, (iii) Hydroboration (iv) Miscellaneous: Tributyltin hydride, Wilkinson's catalyst.

2. **Oxidation :** (i) Oxidation with peracids: Oxidation of carbon-carbon double bonds (Sharpless epoxidation), carbonyl compounds, allylic carbon-hydrogen bonds, (ii) Oxidation with selenium dioxide and Osmium tetraoxide, (iii) Woodward and Prevost hydroxylation.

3. **Reagents and Reactions :**
   (i) Gilman's reagent – Lithium dimethylcuprate
   (ii) Lithium diisopropylamide (LDA)
   (iii) Dicyclohexyl carbodiimide (DDC)
   (iv) 1,3-Dithiane (Umpolung reagent)
   (v) Trimethylsilyl iodide
   (vi) Peterson's synthesis
   (vii) Bakers yeast
   (viii) Organophosphorus compounds (Wittig reaction)
   (ix) Sulphur ylides
   (x) Phase transfer catalysts: Quaternary ammonium and phosphonium salts, Crown ethers.
   (xi) Heck reaction
   (xii) Suzuki coupling
   (xiii) Mukaiyama reaction

Books Recommended

1. H.O. House, *Modern Synthetic Reactions*, 2nd Edition (1972), Benjamin/Cummings Publishing Company, California.

2. L.F. Fieser and M. Fieser, *Reagents for Organic Synthesis,* Vol. 1-16, Wiley-Interscience, New York.

3. M.B. Smith and J. March, *March's Advanced Organic Chemistry – Reactions, Mechanisms & Structure*, 5th ed. (2001), Wiley-Interscience, New York.

4. M. B. Smith, *Organic Synthesis,* (1995) McGraw Hill Inc., New York.

5. J. Clayden, N. Greeves, S. Warren, and P. Wothers, *Organic Chemistry,* (2001) Oxford Univ. Press, Oxford.

6. P. R. Jenkins, *Organometallic Reagents in Synthesis,* (1992) Oxford Science Publ., Oxford.

MCH-544(O) : HETEROCYCLES AND VITAMINS

40 Lectures

1. **General Considerations :** The Disconnection Approach and Retrosynthesis.
2. **The Chemistry of :** (i) Three-membered rings-Aziridines, (ii) Four-membered rings- Azetidines and their 2-Oxo derivatives, (iii) Condensed pyrroles- Indoles, (iv) Azoles- Oxazoles, isoxazoles, pyrazoles, imidazoles and thiazoles, (v) Six-membered rings- Pyrimidines and purines. Structure and synthesis of Caffeine.
3. **Vitamines :** Structure determination and synthesis of Thiamine (B1), Pyridoxine (B6) and Biotin (H)

Book Recommended

1. I.L. Finar, *Organic Chemistry*, Vol. II, 5th Edition (1975 Longman Ltd., New Delhi.
2. T.L. Gilchrist, *Heterocyclic Chemistry*, 3rd Edition (1997) Addison-Wesley Longman Ltd., England
3. R.K. Bansal, *Heterocyclic Chemistry: Syntheses,Reactions and Mechanisms*, 3rd Edition (1999), New Age International, Publisher, New Delhi.
4. A.R. Katritzky and A.F. Pozharskii, *Handbook of Heterocyclic Chemistry*, 2nd Edition (2000), Pergamon Press, Oxford.
5. *Advances in Heterocyclic Chemistry*, A.R. Katritzky (Editor), Academic Press, New York.
6. *Heterocyclic Compounds*, A. Weissberger (Editor), Interscience, New York.

Physical Chemistry Specialization

MCH-543(P) : STATISTICAL MECHANICS

40 Lectures

1. **Review of Basic Statistical Mechanics :** A Review of Thermodynamics and Kinetic theory of gases. Phase space. Ensemble. Liouville theorem. Equal a priori probability. Microcanonical ensemble. Quantization of phase space. Classical limit. Various distributions using micocanonical ensemble. Entropy. Gibbs paradox. Entropy of a two level system. Canonical and grand canonical ensembles. Equipartition of energy. Ideal gas in canonical and grand canonical ensembles.
2. **Partition Function:** Review of rotational, vibrational and translational partition functions. Application of partition function to specific heat of solids and chemical equilibrium. Real gases.
3. **Bose-Einstein Distribution :** Einstein condensation. Thermodynamic properties of ideal BE gas.

4. **Fermi-Dirac Distribution :** Degenerate Fermi Gas. Electron in metals. Magnetic susceptibility.
5. **Fluctuations :** Mean square deviation and fluctuation in ensembles. Concentration fluctuation in quantum statistics.
6. **Non-equilibrium States :** Boltzmann transport equation.Particle diffusion. Electrical conductivity

Books Recommended

1. B.K. Agarwal and M. Eisner, *Statistical Mechanics*, (1988) Wiley Eastern, New Delhi.
2. D.A. McQuarrie, *Statistical mechanics*, (1976) Harper and Row Publishers, New York.

MCH-544(P) : PHYSICAL METHODS IN CHEMISTRY

40 Lectures

1. **Electrochemical Techniques :** Impedance technique -- its application for studying electrode kinetics and corrosion. Application of Rotating Disc Electrode (RDE) for measurement of electrochemical rate constant.
2. **Vibrational Spectroscopy :** Vibration of polyatomic molecules. Introduction to normal coordinate analysis. IR and Raman transitions. Applications to surface studies. Reflection-absorption Infrared spectroscopy (RAIRS). Electron energy loss spectroscopy (EELS).
3. **Photoelectron Spectroscopy and Related Techniques :** Principle and applications to studies of molecules and surface. UPES and XPS. Auger electron and X-ray fluorescence spectroscopy (AES and XRF).
4. **Techniques for Studying Surface Structure:** Low energy electron diffraction (LEED). Scanning tunneling and atomic force microscopy (STM and AFM).
5. **Neutron Diffraction :** Principle and applications.

Books Recommended

1. A.J. Bard and L.R. Faulkner, *Electrochemical Methods : Fundamentals and Applications*; 2nd edition (2001), John Wiley & Sons, New York.
2. J.M. Hollas, *Modern Spectroscopy,* 4th edition (2004), John Wiley and Sons, Chichester.
3. C.N. Banwell and E.M. Mc Cash, *Fundamentals of Molecular Spectroscopy*, 4th edition (1994), Tata McGraw Hill, New Delhi.
4. E.M. Mc Cash, *Surface Chemistry*, (2001) Oxford University Press, Oxford.
5. A.K. Cheetham and P Day, *Solid State Chemistry Techniques*, (1988) Oxford Univ. Press, Oxford.

Minor Electives
Group-A

MCH-631 : MATERIALS CHEMISTRY

25 Lectures

1. **Introduction :** Materials and their classification, Role of Chemistry in Material design.
2. **Synthesis and Characterization of Materials :** Preparative techniques: Ceramic methods; chemical strategies, chemical vapour deposition; preparation of nanomaterials, Langmuir- Blodgett Films. Fabrication of ordered nanostructures . Composition and purity of materials.
3. **High- Tc Oxide Superconductors :** Structural features of cuprate superconductors. 1-2-3 and 2-1-4 cuprates; structure. Normal state properties: anisotropy and temperature dependence of electrical resistance. Superconducting state: heat capacity, coherence length, relation between Tc and hole concentration in cuprates; mechanism of superconductivity in cuprates. Applications of high Tc-cuprates.
4. **Organic Materials :** Conducting organics - Metals from molecules, charge transfer materials and conducting polymers. Organic superconductors. Fullerenes. Molecular ferromagnets and ferroelectrics. Liquid crystals: mesomorphic behaviour, optical properties of liquid crystals, display devices.
5. **Non-linear materials :** Second and third order non-linear effects; molecular rectifiers and frequency doublers; unimolecular electronic devices. Photochromic materials; optical data storage, memory and switches.

Books recommended

1. A.R. West, *Solid State Chemistry and its Applications*, (1984) John Wiley & Sons, Singapore.
2. C.N R. Rao and J. Gopalkrishnan, *New Directions in Solid State Chemistry*, (1997) Cambridge Univ. Press.
3. T. V. Ramakrishnan and C.N.R. Rao, *Superconductivity Today,* (1992) Wiley Eastern Ltd., New Delhi.
4. P. Ball, *Designing the Molecular World: Chemistry at the Frontier*, (1994) Princeton Univ. Press.

MCH-632 : POLYMER CHEMISTRY

25 Lectures

1. **Polymers and their Characterization :** Basic concepts of Polymer Science. Molecular forces and chemical bonding in polymers. Polymer solutions and fractionation: gel permeation chromatography and molecular weight distribution. Polymer molecular weights- determination by methods of osmometry, viscometry, light scattering and ultra centrifugation. Molecular weight distribution curves.

2. **Polymerization :** Mechanism and kinetics of step-growth and chain growth polymerization-radical, ionic, coordination and ring opening polymerization. Copolymerization, reactivity ratios. Polymerization techniques and polymer reactions.
3. **Polymer Structure and Physical Properties :** Configuration of polymer chains. Crystal structure of polymers. Crystallization and melting. The glassy state and the glass transition.
4. **Speciality Polymers :** Solid Polymer electrolytes (SPE). Block copolymers. Polymer colloids. Inter-penetrating network (IPN) polymers. Biomedical polymers.

Books Recommended

1. F.W. Billmeyer, Jr., *Text Book of Polymer Science*, 3rd edition (1984), Wiley-Interscience, New York.
2. G. Odien, *Principles of Polymerization,* 3rd edition (1991) John Wiley & Sons, Singapore.
3. P. Bahadur and N.V. Sastry, *Principles of Polymer Science*, (2002) Narosa, New Delhi.

MCH-633 : MOLECULAR REACTION DYNAMICS

25 Lectures

1. **Introduction :** Reaction kinetics and dynamics. From Cross-sections to rate coefficients.
2. **Potential Energy Surfaces :** Types of potential energy surface. Experimental probes for potential energy surfaces. Motion over the surface
3. **The Differential Cross-Section :** Elastic Scattering. Reactive Scattering. Case Studies. Stereochemistry.
4. **State-Specific Cross Sections :** Experimental considerations- Molecular beam and Spectroscopic experiments. Models of energy utilization and disposal. Kinematic constraints. Case Studies. Rate coefficients and illustrative experiments.

Books Recommended

1. M. Brouard, *Reaction Dynamics*, Oxford University Press, Oxford (1998)
2. R.D. Levine and R.B. Bernstein, *Molecular Reaction Dynamics and Chemical Reactivity*, Oxford University Press, Oxford. (1987)

MCH-634 : RADIO- AND RADIATION CHEMISTRY

25 Lectures

1. **Radiochemistry:** Radiation detection & measurements--Proportional, Geiger-Muller and Scintillation counters, semiconductor detectors & autoradiography, Radiochemical principles in the use of tracers; Applicatons of radioisotopes as tracers (activation analysis, isotope dilution technique,

radiochromatography, neutron absorptiometry & radiometric titrations). Age determination, Medical applications, some agricultural applications.

2. **Radiation Chemistry :** Elements of radiation chemistry,: Interaction of radiation with matter, interaction of γ-radiation with matter, units for measuring radiation absorbed, radiation dosimetry. Radiolysis of water & aqueous solutions : Free radicals in water radiolysis; radiolysis of some aqueous solutions; A time scale of radiolytic events.

Books Recommended

1. H.J. Arnikar, *Essentials of Nuclear Chemistry*, 4th Edition (1995), Wiley Eastern, New Delhi.
2. G. Fridlander, J.W. Kennedy, E. S. Macias, and J. M. Miller, *Nuclear & Radiochemistry*, 3rd Edition (1981), John Wiley, New York.

MCH-635 : MEDICINAL CHEMISTRY

25 Lectures

1. **Structure and activity :** Relationship between chemical structure and biological activity (SAR). Receptor Site Theory. Approaches to drug design. Introduction to combinatorial synthesis in drug discovery.
2. **Antibiotics and antibacterials:**
   - (i) Introduction
   - (ii) Antibiotic β-Lactam type - Penicillins, Cephalosporins
   - (iii) Antitubercular - Streptomycin
   - (iv) Broad spectrum antibiotics - Tetracyclines
   - (v) Anticancer - Dactinomycin (Actinomycin D)
   - (vi) Antifungal – polyenes
   - (vii) Antibacterial – Ciprofloxacin, Norfloxacin
   - (viii) Antiviral – Acyclovir
3. **Antimalarials :** Chemotherapy of malaria. SAR. Chloroquine, Chloroguanide and Mefloquine
4. **Non-steroidal Anti-inflammatory Drugs :** Diclofenac Sodium, Ibuprofen and Netopam
5. **Antihistaminic and antiasthmatic agents :** Terfenadine, Cinnarizine, Salbutamol and Beclomethasone dipropionate.

Books Recommended

1. A. Burger, *Medicinal Chemistry*, Vol. I-III, (1995) Wiley Interscience Publications, New York.
2. W. O. Foye, *Principles of Medicinal Chemistry*, 3rd Edition (1989), Lea & Febiger/ Varghese Publishing House, Bombay.
3. D. Lednicer and L. A. Mitscher, *The Organic Chemistry of Drug Synthesis*, Vol. I-III, Wiley Interscience.
4. A. Kar, *Medicinal Chemistry*, (1993) Wiley Eastern Ltd., New Delhi.
5. N. K. Terrett, *Combinatorial Chemistry,* (1998) Oxford Univ. Press, Oxford.

MCH-636 : ORGANIC PHOTOCHEMISTRY

25 Lectures

1. **Introduction and Basic Principles of Photochemistry :** Absorption of light by organic molecules, properties of excited states, mechanism of excited state processes and methods of preparative photochemistry.
2. **Photochemistry of alkenes and related compounds :** Isomerization, Di-π-methane rearrange-ment and cycloadditions.
3. **Photochemistry of aromatic compounds :** Ring isomerization and cyclization reactions.
4. **Photochemistry of carbonyl compounds**: Norrish type-I cleavage of acyclic, cyclic and β, γ-unsaturated carbonyl compounds, Norrish type-II cleavage. Hydrogen abstraction: Intramolecular and intermolecular hydrogen abstraction, photoenolization. Photocyclo-addition of ketones with unsaturated compounds: Paterno-Buchi reaction, photodimerisation of α, β-unsaturated ketones, rearrangement of enones and dienones, Photo-Fries rearrangement.

Books Recommended

1. John D. Coyle, *Introduction to Organic Photochemistry*, (1986) John Wiley and Sons, New York.
2. C.H. Depuy and O.L. Chapman, *Molecular Reactions and Photochemistry*, 2nd Edition (1988), Prentice-Hall of India (P) Ltd., New Delhi.
3. W.M. Horspool, *Aspects of Organic Photochemistry*, Academic Press, New York.
4. F.A. Carey and R.J. Sundberg, *Photochemistry* in *Advanced Organic Chemistry*, Chapter 13, Part A, 3rd Edition (1990), Plenum Press, New York.
5. N. J. Turro, *Modern Molecular Photochemistry,* (1991) University Science Books, Sausalito.

MCH-637 : FORENSIC ANALYSIS

25 Lectures

1. **Introduction :** Profile of a forensic laboratory, Forensic Scientists role and quality control, Crime-scene investigation, Collection and preserving physical evidences and evidentiary documentation, Future prospects of forensic analysis.

2. **Real Case Analysis :** Liquor analysis, Trap-case analysis, Petroleum product analysis, Fire and Debris analysis, Injuries, Firearm wounds, Asphyxia and stress analysis (only analytical identifications).

3. **Forensic Toxicology :** Analysis of various types of poisons (corrosive, irritant, analgesic, hypnotic, tranquilliser, narcotic, stimulants, paralytic, antihistamine, domestic and industrial (gaseous and volatile) poisoning and food poisonings), Explosive and explosion residue analysis, Lethal drug analysis (sampling, sealing, packing, laboratory methods of testing, reporting the analysis results, court evidence and medico-legal aspects for the consideration of chemical data as a proof for crime), Importance of physiological tests in forensic toxicology.

4. **Instrumentation for Forensic Analysis :**

   (a) Physical, Biological and Chemical Methods : Non-destructive testing probes including radiography, Xera-radiography, Surface penetrations method (SEM and Laser Probes), Fluoroscopy, Immunological methods, DNA-finger printing, Examination and grouping of blood strains and seminal strains, Data retrieval and automation techniques for forensic examination with reference to presence of drugs, glasses, paints, oils and adhesives at crime spot.

   (b) Instrumental Methods : Sample preparation, Calibration of the instruments for its accuracy and producibility of results in forensic analysis, Method validation technique and requirements, Procurement of standard samples, Forensic applications of TLC, HPTLC, HPLC, GC, FT-IR, AAS, GC-MS, UV-visible spectrophotometer with emphasis over standard operational procedures (SOPs) for test samples.

Books Recommended

1. W.J. Welcher (Ed.), *Scott's Standard Methods of Chemical Analysis*, Vol. III A, 6th Edition (1966), and vol. III B, 5th Edition (1975), Van Nostrand Reinhold Co. London.

2. Peter Fordham, *Non-destructive Testing Techniques,* 1st edition (1968), London Business Publications Ltd., London

3. W. Horwitz, *Official Methods of Analysis*, 11th Edition (1970), Association of Official Analytical Chemists, Washington DC.

4. K. Simpson and B. Knight, *Forensic Medicine*, 9th Edition (1985), Edward Arnold Publishers Ltd., London.

Group-B

MCH-641 : MODERN NUCLEAR MAGNETIC RESONANCE TECHNIQUES

25 Lectures

1. A review of one dimensional NMR spectroscopy.
2. Spin-relaxation. Nuclear Overhauser effect (NOE). Polarisation transfer.
3. Two-dimensional NMR. Correlated spectroscopy (COSY)
4. Nuclear Overhauser effect spectroscopy (NOESY)
5. Heteronuclear correlation spectroscopy (HETCOR)
6. Solid-state NMR
7. Magnetic Resonance Imaging (MRI)

Books Recommended

1. A.E. Derome, *Modern NMR Techniques for Chemistry Research*, Pergamon, Oxford (1987)
2. J.K.M. Sanders and B.K. Hunter, *Modern NMR Spectroscopy,* 2nd edition (1993), Oxford University Press, Oxford.
3. R.K. Harris, *Nuclear Magnetic Resonance Spectroscopy*, (1986) Addison-Weslay, Longman Ltd., London.

MCH-642 : INORGANIC PHOTOCHEMISTRY

25 Lectures

1. **Basic Principles**: Photochemical laws – Franck-Condon principle, radiative lifetimes, quantum yields, quenching rates and mechanisms
2. **Photochemistry of Transition Metal Complexes**: Photoreactions of complexes of Cr(III) – photo-aquation, photo-substitution and photo-racemization; Photo-substitution and photoredox reactions of Co(III) complexes; Ru(II) polypyridyl and dinuclear Rh(I) isocyanide complexes as sensitizers; supramolecular complexes as antenna. Applications of quenching and sensitization techniques in the identification of reactive state in coordination complexes
3. **Photochemistry of Transition Metal Carbonyls**.

Books Recommended

1. D. M. Roundhill, *Photochemistry and Photophysics of Metal Complexes*, (1994) Plenum Press, New York and London.
2. G. J. Ferraudi, *Elements of Inorganic Photochemistry*, (1988) John Wiley & Sons.
3. V. Balzani and V. Carassiti, *Photochemistry of Coordination Compounds*, (1970) Academic Press, London.
4. O. Horvath and K.L. Stevenson, *Charge Transfer Photochemistry of Coordination Complexes*, (1993) VCH Publishers Inc.

MCH-643 : BIO-ORGANIC CHEMISTRY

25 Lectures

1. **Enzymes and Mechanism of Enzyme Action:** Classification, isolation and purification. Methods of Enzyme analysis. Kinetics of enzyme action - Michaelis-Menten equation. Different plots for determination of K_m and V_{max} and their physiological significance; Two substrate reactions; Enzyme inhibition. Mechanism of action of chymotrypsin, aldolase, alcohol dehydrogenase, and lysozyme.

2. **Co-enzyme Chemistry :** Cofactors as derived from vitamins; coenzymes, prosthetic groups, and apoenzymes. Structure and biological functions of coenzyme A, thiamine Pyrophosphate, Pyridoxal phosphate, NAD^+, $NADP^+$, FMN, FAD, lipoic acid, and vitamin B_{12}. Mechanisms of reactions catalysed by the above cofactors.

3. **Biotechnological Applications of Enzymes :** Techniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, application of immobilized enzymes, use of enzymes in food and drink industry-Brewing and cheese-making, syrups from corn starch, enzymes as targets for drug design.

Books Recommended

1. A.L. Lehninger, *Principles of Biochemistry,* (1992) CBS Publishers, Delhi.
2. D. Voet, J.G. Voet & CW Pratt, *Fundamentals of Biochemistry*, (1999) John Wiley & Sons, New York.
3. H.R. Mahler and E.H. Cordes, *Biological Chemistry*, 2nd Edition, (1971) Harper and Row Pub., New York.
4. T.C. Bruice and S. Bentkovic, *Bioorganic Mechanisms*, Vol. I & II, (1966) W. A. Benjamin, New York.
5. H. Dugas and C. Penney, *Bioorganic Chemistry: A Chemical Approach to Enzyme Action*, (1981) Springer- Verlag, New York.
6. C. Walsh, *Enzymatic Reaction Mechanisms*, W.H. Freeman & Co., New York.

MCH-644 : CHEMICAL APPLICATIONS OF GROUP THEORY

25 Lectures

1. **A review of Molecular Symmetry and Group Theory**

2. **Molecular Orbital Theory :** Three-centre bonding, symmetry based selection rules for cyclization reactions, dimerization of ethylene, Diels-Alder reactions, Intramolecular cyclization.

3. **Hybrid Orbitals and Molecular Orbitals :** Molecular orbitals for AB_n type molecules; the group theoretical approach to bonding in H_2O and NH_3.

4. **Ligand Field Theory :** Splitting of levels and terms in a chemical environment, energy level diagrams, construction of energy level diagrams, estimation of orbital energies, selection rules and polarizations.

5. **Molecular Vibrations :** The symmetry of normal vibrations, determining the symmetry types of the normal modes, selection rules for fundamental vibrational transitions (IR and Raman); illustrative examples.

Books Recommended

1. F. A. Cotton, *Chemical Applications of Group Theory*, 3rd Edn. (1999), John Wiley & Sons, New York.
2. G. L. Miessler and D. A. Tarr, *Inorganic Chemistry*, 2nd Edn. (1999), Prentice Hall International Inc., London.
3. K. Veera Reddy, *Symmetry and Spectroscopy of Molecules*, (1999) New Age International Pvt. Ltd., New Delhi.

MCH-645 : INDUSTRIAL CHEMICAL ANALYSIS AND QUALITY CONTROL

25 Lectures

1. **Analytical Chemometrics :** General introduction and its application in optimisation, Modelling and parameter estimation, Sampling, calibration, Factor analysis, Resolution, Signal processing, Structure-property relationship, Pattern recognition, Propagation of measurement uncertainties (inaccuracy and imprecision), Analytical validation techniques, Non-linear regression analysis, Good manufacturing practice (GMP), Good lab practice (GLP), lab and industrial safety.

2. **Analysis of Special Industrial Material (General Strategy for Analysis) :** Analysis of dairy products, oils, soaps and synthetic detergents, food additives, petrochemicals (including liquid and gaseous fuels) pesticides, drugs and pharmaceuticals, fertilizers and paints.

3. **Clinical Analysis :** Sampling and selective analysis of biological fluids (using routine and automatic instruments): glucose, bilirubins, total cholesterol, haemoglobin, creatinine, total proteins, albumin, urea-nitrogen, carticosteroids and barbiturates. Immunological methods of analysis: ELISA, RIA and Immunodiffusion.

4. **Chemical Sensors :** Principles, types of chemical sensors based on the modes of transductions, Types of chemical sensor based on the chemically sensitive materials (solid electrolyte, gas, semiconductor), Humidity sensors, Biosensors, Electrochemical sensors (Potentiometric sensors, Ion-selective electrodes, Membrane electrodes, Amperometric sensors, Clark and Enzyme electrodes).

Books Recommended

1. S.J. Haswell , *Practical Guide to Chemometrics*, (1992) Marcel Deckker, Inc., New York.

2. D.C. Garratt, *The Quantitative Analysis of Drugs*, 2nd Edition (1992), Chapman and Hall Ltd., London.
3. F. J. Welcher, *Standard Methods of Chemical Analysis*, Vol. III A, 6th Edition (1966), Vol. III B, 5th Edition (1975), Van Nostrand Reinhold, London.
4. D.A. Skoog, *Principles of Instrumental Analysis*, 3rd Edition (1985), Saunders College Publishing, Philadelphia, London.
5. W. Horwitz (Editor), *Official Methods of Analysis*, 11th Edition (1970), Association of Official Analytical Chemists, Washington DC.

MCH-646 : NUCLEAR CHEMISTRY

25 Lectures

1. **Nuclear Models :** Liquid drop and shell models, elementary ideas about collective model, Fermi gas model
2. **Radioactive Decay Processes :** Alpha decay- penetration of potential barriers, hindered alpha decay, alpha decay energies. Beta Decay- Fermi theory, energy, Curie plots, comparative half-lives, electron capture, selection rules, forbidden transitions, non-conservation of parity, neutrinos. Gamma decay- life-time of excited states, multipole radiation and selection rules, isomeric transition, internal conversion and Auger effect.
3. **Nuclear Energy :** Basic principles of chain reacting systems, the 4-factor formula, Classification of reactors, Breeder reactor, Reactor associated problems, Reactor safety, Fuel cycle, Re-processing of spent fuel, Nuclear waste management.

Books Recommended

1. H.J. Arnikar, *Essentials of Nuclear Chemistry*, 4th Edition (1995), Wiely-Eastern Ltd., New Delhi.
2. G. Fridlander, J.W. Kennedy, E.S. Macias and J.M. Miller, *Nuclear & Radiochemistry*, 3rd Edition (1981) John-Wiley & Sons, New York.

MCH-647 : PHOTOCHEMISTRY

25 Lectures

1. **Photophysical Processes in Electronically Excited Molecules :** Radiationless transition-fluorescence emission. Triplet states and phosphorescence emission. Photophysical kinetics of unimolecular prosesses. Delayed fluorescence.
2. **Photophysical Kinetics of Bimolecular Processes :** Bimolecular collisions in gases and vapours and the mechanism of fluorescence quenching. Kinetics of collision quenching – Stern-Volmer equation. Concentration dependence of quenching and excimer formation. Mechanism of quenching.

3. **Photochemical Primary Processes :** Rate constant and lifetime of reactive energy states. Types of photochemical reactions.

4. **Techniques :** Measurement of emission characteristics – fluorescence, phosphorescence, and chemiluminescence. Techniques for the study of transient species in photochemical reactions. Lasers in photochemical kinetics.

5. **Some Current Topics in Photochemistry :** Chemistry of stratospheric ozone. Plant photosynthesis. Photodynamic therapy of tumor.

Books Recommended

1. J.G. Calvert and J.N. Pitts, Jr., *Photochemistry,* (1966) John Wiley & Sons, New York.
2. K. K. Rohtagi-Mukherjee, *Fundamentals of Photochemistry,* (1986) New Age International, New Delhi.
3. R. P. Wayne, *Principles and Applications of Photochemistry,* (1988) Oxford University Press, Oxford.
4. N. J. Turro, *Modern Molecular Photochemistry,* (1991) Univ. Science Books, Sansalito.
5. J. F. L. Lakowicz, *Principles of Fluorescence Spectroscopy,* 2nd Edition (1999), Plenum Publishers, New York.

Laboratory Work

I SEMESTER

MCH-416 : Laboratory Work-I

MCH-416(I) : Inorganic Chemistry Practical

1. Preparation, purification and structural studies (magnetic, electronic and IR) of inorganic complex compounds:
   (i) *trans*-potassium diaquabis(oxalato)chromate(III), *trans*-$K[Cr(ox)_2(H_2O)_2]$
   (ii) *cis*-potassium diaquabis(oxalato)chromate(III), *cis*-$K[Cr(ox)_2(H_2O)_2]$
   (iii) tris(acetylacetonato)manganese(III), $[Mn(acac)_3]$.
   (iv) sodium hexanitritocobaltate(III), $Na_3[Co(ONO)_6]$.
   (v) pentaamminemonochlorocobalt(III) chloride, $[CoCl(NH_3)_5]Cl_2$.
   (vi) pentaammineaquacobalt(III) chloride, $[Co(H_2O)(NH_3)_5]Cl_3$ by using $[CoCl(NH_3)_5]Cl_2$ as the starting material.
   (vii) pentaamminenitritocobalt(III) chloride, $[Co(ONO)(NH_3)_5]Cl_2$ by using $[CoCl(NH_3)_5]Cl_2$ as the starting material.
   (viii) pentaamminenitrocobalt(III) chloride, $[Co(NO_2)(NH_3)_5]Cl_3$ by using $[Co(ONO)(NH_3)_5]Cl_2$ as the starting material.

2. Semi-micro qualitative analysis of a mixture containing five cations of rare elements and insolubles:
   (ii) Rare elements: Tl, W, Se, Mo, Ti, Zr, Ce, Th, V, U, Li
   (iii) Insolubles: $PbSO_4$, $SrSO_4$, Al_2O_3, Cr_2O_3, Fe_2O_3, SnO_2, TiO_2, ThO_2, $WO_3.xH_2O$

MCH-416(O) : Organic Chemistry Practical

1. Determination of neutralization equivalent of organic acids.
2. Identification of compounds having one or more functional groups.
3. Preparation of compounds and intermediates involving up to two steps.

MCH-416(P)-Physical Chemistry Practical

1. Saponification of ethyl acetate with sodium hydroxide by chemical method.
2. Comparison of acid strengths through acid catalyzed methyl acetate hydrolysis.
3. Energy of activation of acid catalyzed hydrolysis of methyl acetate.
4. Distribution coefficient of I_2 between two immiscible solvents.
5. Conductometric titration of a weak acid with strong base.
6. Conductometric titration of a mixture of weak and strong acids.
7. Determination of solubility and solubility product of sparingly soluble salt conductometrically.
8. Conductometric titration of KCl with $AgNO_3$.
9. Molecular weight of a non-electrolyte by cryoscopic method.
10. Plateau of GM tube and study of counting statistics.

II SEMESTER

MCH-427 : Laboratory Work-II

MCH-427(I) : Inorganic Chemistry Practical

1. Quantitative separation and determination of the following pairs of metal ions using gravimetric and volumetric methods:
   (i) Ag^+ (gravimetrically) and Cu^{2+} (volumetrically),
   (ii) Cu^{2+} (gravimetrically) and Zn^{2+} (volumetrically),
   (iii) Fe^{3+} (gravimetrically) and Ca^{2+} (volumetrically) and
   (iv) Mg^{2+} (gravimetrically) and Ca^{2+} (volumetrically)
2. Separation of a mixture of cations/anions by paper chromatographic technique using aqueous/non-aqueous media:
   (i) Pb^{2+} and Ag^+ (aqueous & non-aqueous media)
   (ii) Co^{2+} and Cu^{2+} (non-aqueous medium)
   (iii)Cl^- and I^- (aqueous-acetone medium)
   (iv)Br^- and I^- (aqueous-acetone medium)

MCH-427(O) : Organic Chemistry Practical

1. Preparation of compounds involving not more than two steps.
2. Systematic identification of mixtures containing two compounds.

MCH-427(P) : Physical Chemistry Practical

1. Rate constant of acid catalyzed hydrolysis of sucrose by polarimetric method.
2. Rate constant of acid catalyzed hydrolysis of sucrose by chemical method.
3. Rate constant of $FeCl_3$-catalyzed H_2O_2 decomposition by gasometric method.
4. Degree of hydrolysis of urea hydrochloride by kinetics method.
5. Equilibrium constant of $KI + I_2 \Leftrightarrow KI_3$ by distribution method.
6. Phase diagram of a binary organic system (Naphthalene and Diphenyl).
7. Potentiometric titration of a strong acid with strong base using quinhydrone electrode.
8. Potentiometric titration of a redox system (ferrous ammonium sulfate with $K_2Cr_2O_7$).
9. Adsorption of acetic acid on charcoal to verify Freundlich adsorption isotherm.
10. Determination of half-life of a radionuclide.

III SEMESTER

MCH-535 : Laboratory Work-III
(Analytical Chemistry Specialization)

1. Determination of ferrous ammonium sulfate potentiometrically with standard ceric sulfate solution (Direct and back titration).
2. Micro determination of magnesium present in a given sample with standard Ce (IV) solution potentiometrically through oxinate precipitation.
3. Micro determination of vanadium present in V_2O_5 potentiometrically employing cerate method.
4. Micro determination of glucose using potassium ferrocyanide as internal reagent and Ce (IV) solution as standard titrant.
5. Determination of pH and pK values of a weak acid potentiometrically using quinhydrone electrode.
6. Determination of concentration of halide ion(s) in the given solution potentiometrically.
7. Conductometric titration of (I) strong acid, monobasic weak acid or polybasic weak acid with strong base (ii) zinc with EDTA, and (iii) KCl vs $AgNO_3$.
8. To obtain the protolysis curves involving cases of weak acid, mixture of acids and polybasic acid employing a pH meter and determine the amount of the respective acid (in ppm) in the given solution.
9. Determination of Na_2CO_3 content (in %) of washing soda using a pH meter.
10. Analysis of mixture of carbonate and bicarbonate (percent in ppm range) using a pH meter or suitable indicators.

11. To study the current-potential characteristics of Cd^{2+} ions using DC polarography, sampled DC, cyclic voltammetry and pulse polarographic techniques.
12. Determination of Cd^{2+} ions concentration in given solution polarographically following (I) calibration (ii) standard addition and (iii) the pilot-ion procedures.
13. Determination of Zn^{2+} ions present at the ppm level in the solution employing conventional D.C. and pulse polarographic techniques.
14. Determination of trace metal impurities present in a polluted water sample by anodic stripping voltammetric procedure.
15. Amperometric determination of Zinc with standard EDTA solution.
16. Amperometric titration of lead with standard potassium dichromate solution.
17. Amperometric determination of magnesium (or cadmium) by precipitating it as oxinate and titrating against standard $KBrO_3$ solution.
18. Electrogravimetric estimation of copper, lead, and nickel present in the solution at ppm level.
19. Separation of proteins by polyacrylamide gel electrophoresis.

MCH-535 : Laboratory Work - III
(Inorganic Chemistry Specialization)

1. Synthesis, purification, analysis and structural characterization of coordination complexes of simple and chelating ligands:
   (i) Bis(acetylacetonato) complexes of Cu(II), Co(II), and OV(IV)
   (ii) Cis- and trans-$[Co(en)_2Cl_2]$
   (iii) $[Cr(NH_3)_6]Cl_3$
   (iv) $[Cr(OAc)_2].2H_2O$
   (v) $[Ti(urea)_6]I_3$
   (vi) Organotin complexes
2. Synthesis of a coordination complex using vacuum technique.

MCH-535 : Laboratory Work - III
(Organic Chemistry Specialization)

1. Separation and identification of organic mixtures containing up to three components.
2. Separation by preparative TLC and characterization by spectroscopic methods.

MCH-535 : Laboratory Work - III
(Physical Chemistry Specialization)

1. Kinetics of decomposition of benzene diazonium chloride.
2. Kinetics of decomposition of acidified hydrogen peroxide with potassium iodide and determination of activation energy.
3. Conductometric study of the kinetics of saponification of ethyl acetate.

4. Kinetics of reaction of KI with potassium persulphate and study of salt effect.
5. Determination of transport numbers of Cu^{2+} and SO_4^{2-} by Hittorf's method.
6. Conductometric titration of triple mixture ($HCl+NH_4Cl+KCl$) with (i) NaOH and (ii) $AgNO_3$.
7. Verification of Debye-Huckel-Onsager equation of conductance.
8. Determination of solubility by (i) conductometry and (ii) potentiometry.
9. Conductometric titration of a polybasic acid.
10. Determination of hydrolysis constant of aniline hydrochloride.
11. Determination of thermodynamic ionization constant of a monobasic acid by (i) conductometry and (ii) potentiometry.
12. Verification of the Nernst law of electrode potential.
13. Analysis of halide mixture by differential potentiometry.
14. Comparison of strengths of two acids by polarimetric study of kinetics of inversion of cane sugar.
15. Determination of Hall coefficient of a sample.
16. Determination of band-gap of a semiconductor.

IV SEMESTER

MCH-542 : Computer Applications in Chemistry : Practical
(Common to all)

Computer programming; Exposure to available standard packages like SPSS, Chemdraw, PC Model, MOTECH, TURBOMOLE, MOLPRO, MOLCAS, MM2 and Gaussian.

MCH-545 : Laboratory Work-IV
(Analytical Chemistry Specialization)

I. Statistical Treatment of Results

1. Determination of accuracy, precision, mean deviation, standard deviation, coefficient of variation, normal error curve and least square fitting of certain set of experimental data in an analysis.
2. Composition of two sets of results in terms of significance (Precision and accuracy) by (I) student's t-test, (ii) F-test.

II. Solvent Extraction

3. Determination of Fe (III) by chloride extraction in ether.
4. Determination of Fe(III) as the 8-hydroxy quinolate (oxinate) by extraction in chloroform.

III. Ion Exchange Method

5. Determination of the capacity of an ion exchange (cationic and anionic) resin (column method).
6. Separation of Cd^{+2} and Zn^{+2} quantitatively through an anion exchanger.

IV. Chromatographic Separations

7. Separation of nickel, manganese, cobalt and zinc and determination of R_f values by thin layer or paper strip techniques.

8. To identify the mixture of inorganic cations. (Co^{2+}, Fe^{2+} and Ni^{2+}) by circular paper chromatography.

V. Complexometric and Redox Titrations

9. Metal-EDTA titrations using Eriochrome Black T, Xylenol orange and PAN indicators (only back titration or substitution titration methods.).
10. Estimation of the purity of oxalic acid employing standard Ce(IV) solution.

VI. Precipitations

11. Estimation of magnesium or cadmium as oxinate by titration with standard bromate solution.
12. Estimation of KBr present in the given solution by titrating against std. $AgNO_3$ solution using eosine as indicator.

VII. Organic Microanalysis

13. To estimate the amount of nitrogen in an organic compound as ammonium after a Kjeldahl's digestion by titrating with hypobromite amperometrically.
14. Estimation of the mercapto group in thioglycollic acid by titrating with standard $AgNO_3$ solution amperometrically.

VIII. Inorganic Microanalysis

15. Identification of various metal ions by chemical microscopy.
16. Identification of various metal ions (with limits of sensitivity) by spot tests.

IX. Spectrophotometric Analysis

17. Spectrophotometric determination (in ppm) of Fe (II) or Fe(III) using 1,10 Phenanthroline (or thiocyanate) as colorimetric reagent.
18. Colorimetric determination of chromium (VI) (in ppm) using 1,5 diphenyl carbazide as a reagent for colour development.
19. Quantitative analysis of APC tablet by NMR or IR spectroscopy.

X. Water Analysis

20. Analysis of water samples for the following parameters; (I) BOD, (ii)COD, (iii) Dissolved oxygen, (iv) total phosphorous, (v) sulfur as SO_2, (vi) total hardness and chloride.
21. Qualitative tests for copper, lead, fluoride in tap water by spot test method.

MCH-545 : Laboratory Work-IV
(Inorganic Chemistry Specialization)

1. Quantitative analysis of tri-component mixture of metal ions using gravimetric, volumetric and spectrophotometric techniques.
   (i) Mixed solution of Cu^{2+}, Ni^{2+} and Zn^{2+}
   (ii) Mixed solution of Cu^{2+}, Ni^{2+} and Mg^{2+}
   (iii) Mixed solution of Cu^{2+}, Ag^{+} and Fe^{2+}
   (iv) Mixed solution of Ni^{2+}, Zn^{2+} and Fe^{2+}

2. Structural identification of selected aromatic ligands on the basis of NMR spectral parameters directly to be calculated from the spectra:
   (i) ^{1}H NMR spectrum with D_2O exchange
   (ii) ^{13}C NMR spectra [proton-coupled, SFORD, $^{13}C\{^{1}H\}$ and DEPT spectra]
3. Working out mass spectral fragmentation patterns and interpreting the molecular ion cluster peaks on the basis of EI mass spectra of selected compounds.

MCH-545 : Laboratory Work-IV
(Organic Chemistry Specialization)

1. Preparation of organic compounds involving several stages, characterization of intermediates and final products by IR and NMR spectroscopy.
2. Techniques of organic chemistry: Special practicals involving steam distillation, photoisomerisation and thin layer chromatography etc.
3. Quantitative analysis of (i) sulphur, (ii) halogens, and (iii) nitrogen.
4. Preparation based on azalactone synthesis.
5. Isolation of some natural products.

MCH-545 : Laboratory Work-IV
(Physical Chemistry Specialization)

1. Half-life periods of a source containing two radionuclides.
2. Absorption coefficient of metal absorbers for ^{60}Co γ - rays.
3. β-absorption and $E_{\beta_{max}}$ determination.
4. Scintillation counting and γ - ray spectrometry.
5. Self absorption of a β- source.
6. Ternary phase diagram of water, benzene, and acetic acid.
7. Determination of surface tension by differential capillary method.
8. Determination of molecular weight of a macromolecule by viscometry.
9. Determination of molecular weight by Victor Meyer's method.
10. Cryoscopy and determination of degree of dissociation.
11. Determination of g-value by ESR method.
12. Analysis of a UV spectrum and calculation of oscillator strength and transition moment.
13. Spectrophotometric study on H-bonded complexation.
14. Determination of ionization constant of a weak indicator acid.